ENERGYSOLUTIONS

CASK BOOK
FOR
MODEL 8-120B
USA/9168/B(U)

Energy*Solutions*
Suite 100, Center Point II
100 Center Point Circle
Columbia, South Carolina 29210
Phone: 803.256.0450

Please ensure that you are a registered user before using this package (refer to Section 3).
To verify, please contact the NRC. Thank you!

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I. US NRC Certificate of Compliance Number 9168, Rev. 20, dated November 22, 2013 (as corrected on December 18, 2013)

II. TR-OP-035, Rev. 25, Handling Procedure for Transport Cask Model 8-120B, Certificate of Compliance Number 9168

TR-TP-002, Rev. 20, Air Pressure Drop Test for Model 8-120B Cask, Certificate of Compliance Number 9168

ER-01-002, Rev. 1, Conformance of CNS 8-120B Cask with Specifications for Industrial Packaging Type 1 and Type 2

ER-01-004, Rev. 1, Conformance of CNS 8-120B Cask with Specifications for DOT 7A, Type A Packagings

III. Typical User Registration Letter

IV. Safety Analysis Report for Model 8-120 Type B Shipping Package, Consolidated Revision 7, November 2013

V. Drawings:

- C-110-E-0007, Rev. 19, Sheets 1-6 (withheld as security-related sensitive information)
- DWG-CSK-12CV01-EG-0001-01, Rev.3 (withheld as security-related sensitive information)

VI. References:

- Energy*Solutions* applications and supplements dated May 23, July 3, August 9, September 20, and November 13, 2013.

CHEM-NUCLEAR SYSTEMS, LLC
140 Stoneridge Drive • Columbia, South Carolina 29210 • (803) 256-0450

March 29, 2000

Dear Customer:

In May of 1999, Chem-Nuclear Systems (CNS) asked the NRC for clarification to the condition in the CNS 8-120B Certificate of Compliance 9168, Revision 8 dealing with pre-shipment leak tests. We asked the NRC to clarify the LSA requirements referenced in Condition 8. The NRC gave a verbal interpretation stating that the LSA requirements were the specific activity limits listed in 10 CFR 71.4 (LSA material definition). Chem-Nuclear Systems requested a Certificate of Compliance amendment to reflect this interpretation.

The NRC recently amended the Certificate of Compliance to clarify the condition and has also issued a Safety Evaluation Report to explain the changes. Please be advised that the recent Certificate of Compliance amendment does not reflect the NRC's verbal interpretation from May of 1999. Condition 8 of the CNS 8-120B Certificate of Compliance, Revision 9 now states:

> *"Prior to each shipment, the package must be leak tested in accordance with Section 8.2.2.2 of the application. For contents that meet the definition of low specific activity material or surface contaminated objects in 10 CFR 71.4, and also meet the exemption standard for low-specific activity and surface contaminated objects in 10 CFR 71.10(b)(2), the pre-shipment leak test is not required."*

Therefore, a pre-shipment leak test shall be performed on the 8-120 Type B cask unless its contents are LSA or SCO and the unshielded material has a dose rate less than or equal to 1 rem/hr at 3 meters.

If you have any questions or comments, please call me at (803) 541-5012.

Sincerely,
Chem-Nuclear Systems, LLC

Kevin Lee
Licensing Engineer

KL/jtg

CHEM-NUCLEAR SYSTEMS, LLC
140 Stoneridge Drive • Columbia, South Carolina 29210 • (803) 256-0450

July 7, 1999

CHEM-NUCLEAR SYSTEMS INFORMATION NOTICE
POTENTIAL PROBLEMS ASSOCIATED WITH CASK SHIELD INSERTS

Dear Customer,

For many years, cask shield inserts have been approved for use in certified Low Level Waste Transportation Casks as supplemental shielding or shoring. Several models of Chem-Nuclear Systems (Chem-Nuclear) casks use approved full height shield inserts of varying thicknesses from ½ inch to 2 inches. Cask users have experienced normal fit and function with these inserts, which typically allow for a radial clearance of ½ inch between the insert and the packaging liner. However, specific applications can produce close fitting contents (packaging liners) with minimal dimensional clearances.

Recent experience has shown that, if not properly handled and stored during routine use, cask shield inserts may experience some distortion such as ovalization. This is more pronounced in thinner inserts (i.e. ½ inch thick). This ovalization may however not be readily discernable and may occur by laying the shield insert down on its side without proper reinforcement, resulting in a slight, permanent egg shape.

DESCRIPTION OF POTENTIAL SCENARIO

To characterize the concern, the following scenario is provided which illustrates the potential problem.

A packaging liner (e.g. a 14-170LPRCT liner which consists of a 14-170 HIC inside of a steel shell with an OD of 74 inches) is inserted into a cask which has an out-of-round insert. The typical ½ inch radial clearance would not be achieved. The liner could make contact with the shield insert wall without being noticed and, due to its weight, still slide down sufficiently within the insert and the cask.

During off-load operation, friction or binding between the liner wall and the insert wall may be sufficient to cause the shield insert to be withdrawn as the liner is withdrawn. **THIS CAN POTENTIALLY BE A DANGEROUS SITUATION.** It may not be quickly recognized that the shield insert is being withdrawn with the liner. Under such circumstances, withdrawal may continue until the liner and insert are above the cask lid opening with the potential for the insert to spring loose from the liner and fall free. As a result, severe damage may occur to personnel, the cask or associated equipment from the 2,700 pound insert.

RECOMMENDED ACTIONS FOR USERS

While the example used to demonstrate the concern involves a liner which would be shipped in a 14-195, 14-215 or similar cask, Chem-Nuclear is advising that any shield insert may, if not properly handled, exhibit this potential safety hazard during off-load. Chem-Nuclear recommends that additional care be taken at any time a liner is removed from a cask fitted with a shield insert. Furthermore, Chem-Nuclear recommends that all shield inserts used with the 14-170LPRCT in particular be inspected and gauged for roundness prior to assembly into a cask.

It is our understanding that Customers may be using several older model LPRCT liners (without the smaller OD) with casks fitted with shield inserts provided from sources other than Chem-Nuclear. We recommend that all end users and intermediate handlers incorporate cautionary steps into appropriate procedures for the inspection and gauging of these assemblies before use.

ACTIONS TAKEN BY CHEM-NUCLEAR

Chem-Nuclear has taken the following actions to prevent the described scenario:

- Designed a no-go gauge for shield inserts to be used with the 14-170LPRCT.
- Developed a procedure for use of the no-go gauge, which in addition stipulates pertinent inspection criteria and cautions to be taken during shield insert handling and cask loading and off-loading.
- Revised the 14-170LPRCT shell / baseplate interface design to provide an additional ¼ inch of clearance.

Chem-Nuclear is confident that the implementation of these recommendations will help prevent the inadvertent removal of shield inserts when off-loading liners from casks.

For additional information, please contact Patrick Paquin at (803) 758-1824.

Section 1

Certificate of Compliance

NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGE
9168	20	71-9168	USA/9168/B(U)-96	1 OF	4

2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

EnergySolutions
Suite 100, Center Point II
100 Center Point Circle
Columbia, SC 29210

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

EnergySolutions application, Revision No. 7, dated November 13, 2013.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: 8-120B

(2) Description

A cylindrical carbon steel, lead shielded, packaging designed for the transport of radioactive waste materials. The packaging has four tie-down and two removable lifting devices and is transported in the upright position with cylindrical foam-filled impact limiters, 102 inches outside diameter (OD), installed at each end of the packaging. The overall height of the package with the impact limiters attached is 132 ¼ inches. The maximum gross weight of the package is approximately 74,000 pounds (lbs), as follows:

Packaging Body	42,220 lbs
Lid	7,080 lbs
Payload	14,150 lbs
Impact Limiters	4,860 lbs (each)
Miscellaneous	830 lbs
Package	74,000 lbs

The cavity of the packaging is a right circular cylinder with an internal diameter of 61 13/16 inches and a height of 74 7/8 inches. The package body consists of two shells, both fabricated of ASTM A516, Grade 70 steel. The annular space between the 1½ inch thick external shell and the ¾ inch thick internal shell is filled with 3.35 inch thick lead. The primary lid is attached to the packaging body with twenty equally spaced 2-inch diameter bolts. A supplemental 14 gauge stainless steel sheet is welded to the inside surface of the primary lid.

5(a)(2) Packaging Description (Continued)

The centered secondary lid is attached to the primary lid with twelve equally spaced 2-inch diameter bolts. A thermal shield, consisting of two polished stainless-steel plates separated by a thin air gap, is attached to the secondary lid lifting lugs with hitch-pins. A ½ inch thick steel plate covers the central hollow region of the lower impact limiter. A 12 gauge stainless steel liner is welded to the cavity of the package and the lid surface to protect all accessible areas from contamination.

The containment boundary consists of the inner shell, the upper baseplate, the bolting ring, the inner O-rings of the lids, and the lids. Test ports for leak testing of the package are located between the twin O-ring seals for both the primary and secondary lids.

There are three configurations of the packaging: Configuration 1 includes a drain port, sealed with the insertion and welding of a rod in the drain port; Configuration 2 does not have a drain port; Configuration 3 does not have a drain port and the packaging's base plate is fabricated differently than for Configurations 1 and 2. Fabrication of Configurations 1 and 2 is not authorized.

(3) Drawings

The packaging is constructed and assembled in accordance with Energy*Solutions* Drawing Nos. C-110-E-0007, sheets 1-6, Revision No. 19.

The secondary lid thermal shield is constructed in accordance with Energy*Solutions* Drawing No. DWG-CSK-12CV01-EG-0001-01, Rev. 3.

(b) Contents

(1) Type and form of material

(i) Byproduct, source, or special nuclear material in the form of dewatered resins, solids, including powdered or dispersible solids, or solidified material, contained within secondary containers; or

(ii) Radioactive material in the form of activated metals, or metal oxides in solid form, contained within secondary containers.

(2) Maximum quantity of material per package

(i) Activity not to exceed 3,000 times a Type A quantity along with the following limits:

(1) The limit determined per the procedure in Attachment 1 to Chapter No. 7 of the application for beta and gamma emitting radionuclides.

(2) The mass limits for fissile materials as prescribed by 10 CFR 71.15 for exempting materials from classification as fissile material.

(3) A maximum total package neutron source of $1x10^5$ neutrons/second for materials that produce neutrons (other than fissile materials) through any means, including spontaneous fission, alpha-neutron reactions, and gamma-neutron reactions.

(ii) Maximum decay heat: 200 Watts.

(iii) Maximum weight of contents: 14,150 lbs including shoring and secondary containers.

(iv) Powdered or dispersible solid materials must have a mass of at least 60 grams or a specific activity of 50 A_2/g or less.

(v) Explosives, corrosives, and non-radioactive pyrophorics are prohibited. Pyrophoric radionuclides may be present only in residual amounts below 1 weight per cent.

(vi) Materials that may auto-ignite or change phase at temperatures below 350°F, not including water, shall not be included in the contents. Also, contents shall not include any materials that may cause any significant chemical, galvanic, or any other reaction.

(vii) Powdered radioactive materials shall not include radioactive forms of combustible metal hydrides or combustible element metals, i.e., magnesium, titanium, sodium, potassium, lithium, zirconium, hafnium, calcium, zinc, plutonium, uranium, and thorium, or combustible non-metals, e.g., phosphorus.

(viii) Contents may only include quantities of boron, lithium, or beryllium such that these materials do not constitute quantities sufficient to be considered as a bulk material for a payload item or a portion of that payload item.

6. In addition to the requirements of Subpart G of 10 CFR Part 71:

(i) The package must be prepared for shipment and operated in accordance with the Operating Procedures of Chapter 7 of the application,

(ii) The packaging must be tested and maintained in accordance with the acceptance tests and maintenance program described in Chapter 8 of the application.

7. Except for close fitting contents, shoring must be placed between the secondary containers, or activated components, and the package cavity's walls to prevent both radial and axial movements during transport.

8. Flammable gas (hydrogen) concentration is limited to less than 5% in volume. Compliance with this concentration limit is determined by the methodology used in NUREG/CR-6673.

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGE
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9. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

10. Revision No. 19 of this certificate may be used until August 31, 2014.

11. Expiration date: August 31, 2017.

REFERENCES

Energy*Solutions* application, Revision No. 7, November 13, 2013.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Michele M. Sampson, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Date: November 22, 2013

SAFETY EVALUATION REPORT
Docket No. 71-9168
Model No. 8-120B
Certificate of Compliance No. 9168
Revision No. 20

SUMMARY

By letter dated May 23, 2013, Energy*Solutions* (ES) submitted an amendment request to the U.S. Nuclear Regulatory Commission for the Model No. 8-120B package. ES requested the addition of a steel plate that covers the central hollow region of the lower impact limiter to improve the shielding effectiveness of the package

On July 3, 2013, ES provided inadvertent omissions to its application, and on August 9, 2013, ES provided responses to the request for additional information (RAI) dated July 15, 2013. On September 20 and November 13, 2013, ES provided responses to an RAI letter dated September 16, 2013. NRC staff reviewed the applicant's responses and found that the package meets the requirements of 10 CFR Part 71.

1.0 GENERAL INFORMATION

A ½" thick steel plate has been added to the design of the package to cover the central hollow region of the lower impact limiter. This new plate is credited for radiation shielding under normal conditions of transport (NCT) as explained and justified in Chapter 5 of the application. The maximum gross weight of the package stays the same at 74,000 lbs but the maximum payload weight has been reduced to 14,150 lbs to account for the weight of this added steel plate. Except for those modifications, the design of the package, as well as the authorized contents, remains unchanged.

The staff reviewed Revision 19 of Energy*Solutions*' Drawing No. C-110-E-0007, sheets 1-6, and Revision 3 of Energy*Solutions*' Drawing No. DWG-CSK-12CV01-EG-0001-0.

The staff concludes that the information presented in this section of the application provides an adequate basis for the evaluation of the Model No. 8-120B package against 10 CFR Part 71 requirements for each technical discipline.

2.0 STRUCTURAL EVALUATION

The new cover plate that covers the central hollow region of the lower impact limiter is designed to remain intact and attached to the impact limiter during NCT. However, this cover plate has no significant effect on the energy-absorption characteristics of the impact limiter during the NCT and hypothetical accident conditions (HAC) free drop tests, and therefore is not considered in the NCT and HAC free drop analyses.

The structural evaluation of the package remains unchanged.

3.0 THERMAL EVALUATION

The impact limiters are not explicitly included in the thermal finite element model. For NCT, the impact limiters are conservatively represented by fully-isolated boundary conditions, and only the exposed portions of the fire shield and package body are used for heat rejection to the ambient.

The addition of the new cover plate does not change the thermal evaluation of the package or its results.

4.0 CONTAINMENT EVALUATION

The containment evaluation remains unchanged. The applicant noted an inconsistency between the reference leakage rate (L_R) of 2.2×10^{-6} cm^3/sec stated in the previous revision of the application, based on irradiated hardware, and the reference leakage rate (L_R) for the package of 1.54×10^{-6} ref-cm^3/sec, as mentioned in the corresponding safety evaluation report. This inconsistency did not affect any of the conditions of the certificate.

During the review of this amendment request, ES submitted a notification, dated August 14, 2013, regarding the failure to observe CoC conditions for the package vent port leak test hold time (ADAMS Accession Number ML13247A179). The pre-shipment leakage rate test had been performed using a pressure drop test on the primary lid, secondary lid, and vent port seals. To determine the required hold time for the pressure drop test, a maximum test volume was calculated and, for the lid seal, the maximum hold time was determined to be 60 minutes, and was conservatively used for the smaller pressure drop test volumes of the secondary lid and vent port pre-shipment leakage rate tests. The 60 minute hold time was described in Chapter 7 of the application. However, ES air pressure drop test procedure TR-TP-002 specified a 20 minute hold time for the vent port pre-shipment leakage rate test. Based on equation B.14 in ANSI N14.5, "American National Standard For Radioactive Materials – Leakage Tests on Packages for Shipment," the pressure drop test hold time is proportional to the pressure drop test total volume. In its response to staff's RAI, the applicant showed that the pressure drop test total of the test vent port volume and the test manifold volume was less than one third (20 minutes / 60 minutes) of the pressure drop test total of the primary containment seal test chamber volume and the test manifold volume. Therefore, the 20 minute hold time still provided a substantial margin for detecting any leakage from the vent port and there was no safety significance associated with this issue. The staff recognizes that new lids are used on the packages after August 31, 2013, using different testing procedures in the previous Revision 19 of the CoC.

ANSI N14.5 provides acceptable methods for demonstrating that Type B packages designed for transport of normal-form radioactive material comply with the regulatory containment requirements specified in 10 CFR Part 71. According to ANSI N14.5, a pre-shipment leakage rate test is to be performed on containment boundary seals that have been opened. Based on a 2005 information notice released by Energy*Solutions*, the containment boundary vent port seal could be opened and closed for the shipment of Low Specific Activity (LSA) material or Surface Contaminated Objects (SCO). In previous revisions of the application, a pre-shipment leakage rate test would not have to be performed if the package contained LSA/SCO contents that meet the exemption standards in 10 CFR 71.14(b)(3)(i). However, a potential scenario could occur where Type B contents could be shipped without performing a pre-shipment leakage rate test

on a vent port seal that remained closed during the Type B loading operations, even if the vent port had been opened during a prior loading of LSA/SCO contents. The vent port could also be opened while the package is disassembled, or empty between loading operations. The previous opening of the containment boundary vent port on a prior LSA/SCO shipment is not known during the loading of Type B contents. Consequently, Type B contents could be transported without performing a pre-shipment leakage rate test on a vent port that was opened during a prior loading, or between loading operations. Therefore, to prevent this from occurring, the applicant has deleted the note regarding the exemption from pre-shipment leak testing for LSA and SCO shipments. All shipments made with the package require pre-shipment leakage rate testing as indicated in Chapter 7, Operating Procedures.

Based on the review of the statements and representations in the application, the staff concluded that the containment design of the Model No. 8-120B package has been adequately described and evaluated per the change of contents and the package design meets the containment requirements of 10 CFR Part 71.

5.0 SHIELDING EVALUATION

The purpose of the shielding review is to verify that the package design meets the external radiation requirements of 10 CFR Part 71 for NCT and HAC. The applicant requested an increase in radioactivity levels of about 30% for all contents. The applicant performed a new shielding analysis to support the increase in contents by adding a steel plate to the bottom impact limiter and crediting the additional steel already present in the package. The shielding method was reviewed in detail when the staff issued Revision 19 of the CoC (ADAMS Accession No. ML12236A198). The staff's review focused on the changes to the application, and used the guidance in Section 5 of NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

5.1 Description of Shielding Design

5.1.1 Design Features

The shielding design features a packaging body with a steel base, steel primary and secondary lids, and a steel/lead/steel wall, with dimensions specified in Drawing No. C-110-E-0007, Revision 19. In the shielding analysis that supported Revision 19 of the CoC, the applicant relied on the lead thickness, and the steel components of the packaging (i.e., the radial shells, base plates, and lids). In this amendment request, the applicant also credits the 12 gauge steel liner inside the cavity, the 12 gauge impact limiter steel casing, the 3/16" thick radial thermal barrier, and has included a ½" steel base plate in the "hole" of the bottom impact limiter. This base plate is a new component.

The applicant had also previously modeled nominal dimensions for the steel cask components. The staff found this acceptable in Revision 19 of the CoC because the applicant had not modeled the 12 gauge steel liner inside the cavity. Since the applicant is now crediting this component, the shielding model was changed to account for these design tolerances by reducing the component thicknesses by the tolerance amount specified in the cask drawings. The staff found crediting the inner liner acceptable because the applicant accounted for all fabrication tolerances within their model.

The staff requested information clarifying the drawing with respect to the radial thermal barrier. From Drawing No. C-110-E-0007, the barrier appeared to be discontinuous, and no

discontinuities were accounted for in the shielding model. In response to staff inquiries, the applicant explained that there are discontinuities where there are the lift lug pads and the tie down pads. Based on these other features providing at least an equivalent amount of shielding as the thermal barrier, the staff found the shielding model acceptable.

The staff reviewed the package Drawing No. C-110-E-0007 and verified that the newly credited features were included. The staff found that the figures, certificate drawing, and discussion describing the shielding features are sufficiently detailed to support an in-depth technical evaluation.

5.1.2 Summary Table of Maximum Radiation Levels

The package transports a wide variety of contents and therefore determining the maximum dose rate of all possible contents is not practical. The applicant has instead back-calculated from the allowable dose rate limit the amount of radioactive contents that could be shipped. The summary table of maximum radiation levels includes sample calculations for a Cobalt-60 (Co-60) point source and a Cesium-137 (Cs-137) point source without credit for shoring. Table 5.1 in the application provides the maximum NCT and HAC dose rates for these two cases. The applicant has incorporated a 5% margin into the package operations to offset uncertainties in the shielding evaluation method, and thus ensuring that the package dose rates do not exceed the regulatory limits. The staff found that the package meets the regulatory dose rate limits in 10 CFR 71.47 for exclusive use shipments and the dose rate limits for HAC specified in 10 CFR 71.51 for these two nuclides.

5.2 Radiation Source

Contents proposed for transport include byproduct, source or special nuclear material in the form of dewatered resins, solids, powdered or dispersible solids, solidified materials, or radioactive materials in the form of activated metals or metal oxides in solid form. All these contents are to be contained within a secondary container(s). As described, the proposed contents may contain gamma sources, neutron sources and beta sources, i.e., gamma-emitting, neutron-emitting, and beta-emitting materials.

The proposed contents limits are 3,000 times a Type A quantity with further limits. Gamma-emitting contents are limited to materials with gamma energies up to 3.5 MeV and limited by the procedure in Attachment 1 to Chapter 7 of the application. The limits for gamma sources are in terms of specific gamma energies. There are also specific limits proposed for Co-60 and Cs-137.

In the application, the applicant updated the tables in Attachment 1 to Chapter 7 to increase all gamma contents by approximately 30%.

5.3 Shielding Model

The staff reviewed the structural and thermal chapters of the application and found that conditions consistent with NCT and HAC were appropriately represented in the shielding model. The staff requested additional information about the consideration of NCT tests on the impact limiter dimensions. In response to this inquiry, the applicant updated their model to include the impact limiter deformation as a result of NCT and updated all content limits.

5.3.1 Source and Shielding Configuration

The applicant evaluated the package using different models for NCT and HAC. The components of the package are modeled at the minimum dimensions specified in the certificate drawing. Credit is also taken for the 12 gauge steel cavity liner, radial thermal barrier, and presence of the impact limiters, though the impact limiter foam material is still neglected. For the top and bottom impact limiters, the model includes a steel plate that covers the voided central area of the impact limiters. The applicant uses minimum dimensions for the newly credited components. For HAC models, the impact limiter, including the shield plate, is neglected. The HAC model was also modified to move the source up into the chamfer region of the lid to account for additional streaming.

The applicant did not model this chamfer region in its NCT models. In considering the possible migration of source material up into this region and up into the cask/lid annulus, the staff placed Condition 7 in the Revision 19 of the CoC that states that two independent physical verifications shall be performed to ensure proper closure. This double verification provides reasonable assurance that material cannot migrate into this annulus during NCT. In the application for Revision 20 to the CoC, the applicant proposed to remove this condition from the CoC and add it to the operating procedures. The applicant proposed modification to the language of this condition to waive the double verification requirement for contents that are too big to migrate into that region or for resins that are uniformly distributed and that occupy a significant volume of the cask such that if a small amount of this material were to migrate into this region that its impact on dose rates would be insignificant. The staff used engineering judgment assuming that resins would be transported using a significant volume of the cask – otherwise it would not be economically feasible for a user to ship; and although a small amount of resins could migrate into the cask lid annulus, the staff used engineering judgment to conclude that the amount of activity able to migrate into this region would be negligible. The staff found that the proposed modification would still provide adequate assurance that material could not migrate up into the cask/lid annulus to the extent that any normal condition regulatory dose rate limits would be exceeded.

The allowable contents are so broad that the applicant chooses generic geometries for the contents to bound all the possible contents. These source geometries remain unchanged from the last CoC revision and therefore remain acceptable by the staff.

5.3.2 Material Properties

Materials used in the shielding evaluation are presented in Table 5.3. The applicant did not change any of the material properties in this application from the last revision of the CoC. Therefore the staff's conclusion that they are acceptable remains valid.

5.4 Shielding Evaluation

5.4.1 Methods

The applicant performed shielding calculations with MCNP5, Rev. 1.51. MCNP is a three dimensional Monte Carlo transport code developed and maintained by Los Alamos National Laboratory. The code's capabilities include modeling of and determining dose rates from package design features where radiation streaming may be a concern. This code is used

extensively for shielding calculations by industry. Given the code's capabilities and its extensive application in industry (ensuring the code is well-vetted), the staff found the code acceptable for use in the present application.

Maximum quantities of radioactive material are based on the maximum gamma energy of the content as limited by the emission rate in Table 5-5 over the range of 0.5 MeV to 3.5 MeV. The applicant calculates the values in Table 5-5 by finding the maximum allowed gamma source that meets regulatory limits at the various package surfaces. The applicant uses MCNP to calculate a dose rate response at the prescribed locations on a per source particle basis. The staff reviewed and approved the methods used in this application in the last revision of the CoC and no changes within the current application give the staff cause to believe that they are obsolete or invalid for any reason. Therefore staff's conclusion that they are acceptable remains valid.

5.4.2 Input and Output Data

The applicant provided input files for the MCNP calculations used to determine the maximum radioactivity of the contents. Staff reviewed sample input files and found that the information regarding material properties and dimensions used in the calculations is consistent with descriptions of the calculations given in the application.

The staff compared the calculation results in the calculation file NU-391 from the current application to Revision 5 used with CoC Revision 19 and noticed that there were some dose rate responses that increased despite the additional shielding. The staff would expect in every case that these would decrease. This observation led the staff to speculate that there could either be large uncertainties associated with these calculations or that there could be problems with the calculations' convergence and the staff requested information from the applicant that they explain how the MCNP uncertainty is treated and how convergence is ensured. Due to the large number of calculations used to determine the content limit tables, the staff was unable to review every output file to determine proper convergence.

In response to the staff's request, the applicant provided the relative error (uncertainty) for each calculation as well as information on how this uncertainty is treated. Based on the information submitted by the applicant, the staff determined that the uncertainties are relatively low and treated in a conservative manner. The applicant stated that almost all of the MCNP tallies (calculations) have passed all 10 of MCNP's statistical checks. For tallies that did not pass all of the statistical checks, the applicant provided the procedure they used to determine that each calculation has converged. Each of these calculations was reviewed individually by an analyst. In many cases the tally was not used to determine source limits and would have to increase substantially to affect the content limit curves. In a few cases where tallies were used to calculate content limits, these only missed one statistical check, showed good behavior in relation to other tallies with similar locations and source strengths, and had low uncertainty levels. Therefore, the staff found the information submitted by the applicant demonstrated that each calculation had converged properly.

5.4.3 Flux-to-Dose-Rate Conversion

The applicant used conversion factors that were derived from the ANSI/ANS 6.1.1-1977 standard. The applicant calculated the factors from the polynomial fit for gamma radiation given in that standard. As this is the standard that staff finds acceptable for calculation of dose rates, the staff found the applicant's conversion factors to be acceptable. The conversion factors used in the input files are consistent with those described in the application.

5.4.4 External Radiation Levels

The applicant used the regulatory limits to calculate the maximum quantities of the package contents. The applicant derived a set of limits for various contents configurations and set restrictions on how the user applies those limits to ensure that the regulatory dose rate limits are not exceeded.

The package is designed to transport radioactive materials by exclusive use shipment. Thus, the applicant used the 10 CFR 71.47 dose rate limits for exclusive use shipments. There is no enclosure included with the package design, and there are no conditions regarding the vehicle other than a width of 8 feet. So, the dose rate limits for transport in an open, or flat-bed, vehicle are used in the shielding method.

The applicant determined the source strengths (point sources) and source strength densities (distributed sources) that would meet each NCT and HAC limit for the axial top, axial bottom, and radial side of the package. Since the package is always transported in a vertical position (i.e., the package axis is vertical), the 2 meter NCT dose rate limits were only applied to the package's radial side. These calculations were performed for each of several gamma energies in the range of 0.5 to 3.5 MeV (see Table 5.5 of the SAR) and for the two common source nuclides Co-60 and Cs-137. The results of these calculations were used to create Table 5.5 of the SAR and Table 1 of Attachment 1 to Chapter 7 of the SAR (the package operations).

The quantity limits for distributed sources are in terms of source strength density instead of source strength. To allow some flexibility in this regard for the package contents, the applicant has limits for three distributed source volumes: the entire package cavity, 55 gallon drum and 2.5 ft^3.

The applicant compared the source strengths (point sources) and source strength densities (distributed sources) that were calculated to meet each dose rate limit (NCT and HAC) for the locations described above for each of the selected gamma energies and nuclides. The smallest source strength, or source strength density, that resulted in dose rates at a regulatory limit is the most limiting for the contents and is used in the tables as the limit for the contents' source strength, or source strength density, for each gamma energy, or nuclide, for each contents configuration. For the smaller distributed sources, the comparison includes NCT cases with sources having the respective volumes and HAC cases for the full cavity volume.

The staff found the approach for selecting the smallest source strength, or source strength density, which results in dose rates that equal a regulatory limit, was acceptable since it has not changed since the last revision of the CoC.

For the current application, the staff compared the results of the new calculations crediting the extra shielding with those of the calculations used to support CoC Rev. 19 to ensure that the change in values was reasonable. The staff expected in every case that the dose rate response would decrease due to the additional shielding. However in a few cases, including Cs-137 and calculations for lower energy gammas below 1.0 MeV, there were some dose rate responses that increased. The staff requested additional information from the applicant to explain this increase.

The applicant stated that the reason for this increase was due to the changes in the modeling of the shielding components. As discussed in Section 5.1.1 and 5.3.1 of this SER, by crediting the

inner steel liner, the applicant then reduced the shielding of the other steel components to account for fabrication tolerances (which were previously accounted for with the liner which was not credited). However the bolt ring and seal wear plate were modeled at maximum thickness because it raises the lid relative to the top of the lead and creates a larger streaming path and is therefore a more conservative model. For Cs-137 and some lower gamma energies, this increased the dose rate response. Co-60 and higher gamma energies that have the highest gamma dose rates at the package's axial mid-plane were not affected. Since this is bounding, the staff found this acceptable.

5.4.5 Application of Shielding Method Results

The results of the shielding method are captured in Table 5.5 and Table 1 of Attachment 1 to Chapter 7 in the application. Both Chapter 5 and Chapter 7, Attachment 1, describe how the results are to be applied by the package user to determine acceptability of the contents presented for a shipment.

This method has not changed since the last revision of the CoC and therefore the staff found it acceptable.

5.5 Evaluation Findings

Based on its review of the statements and representations in the application and independent confirmatory calculations, the staff found reasonable assurance that the shielding design has been adequately described and evaluated and that the package meets the external radiation requirements of 10 CFR Part 71.

6.0 CRITICALITY EVALUATION

Not applicable.

7.0 PACKAGE OPERATIONS

The staff also reviewed the package operations to ensure that operations relevant to shielding are adequate. These include the use of shoring to maintain the contents position within the package, performance of dose rate surveys to ensure the package meets the regulatory dose rate limits, which these radiation surveys are sufficient to account for non-uniformity of the source distribution, and that appropriate limits are used for preparation of empty packages.

Section 7.0 was revised to reference Section 8.3.2.1 for the leak test requirements for powdered solid shipments. The leak test requirement for leaktight status, included in Section 4.9 of the application, has been also included in Chapter 8 of the application.

In order to remove Condition No. 7 of the previous CoC, the following changes were made: (i) the last paragraph in Section 7.0 now specifies that shipments of powdered solids do not require a leaktight package, just that the periodic leak test is performed to leaktight standards. This paragraph also refers to Section 8.3.2.1 of the application rather than Section 4.9; (ii) a new step 7.1.21.6 was added for the shipper to confirm that the package was tested leaktight; and (iii) Section 8.3.2.1 of the application was revised to incorporate the requirements from Section 4.9 for leaktight testing.

The applicant included a new step (step 7.1.10) in the operating procedures to require two independent physical verifications of the secondary's container closure system for contents such as activated metals or radioactive sources for which hot particle migration may occur. The basis for the double verification is to ensure that small, high specific activity, particles do not have the potential to migrate up into the annular gap between the primary lid and the package bolting flange. The double physical verification requirement is waived only for uniformly distributed resins, filters, and solidified wastes with no dimensions less than 1 cm. Contents with any form of isotope sources, or with highly activated fines, swarf, crud, or other particles with less than 1 cm in size are not exempt from this requirement.

Regarding step 7.1.21.6, a new requirement was added to ensure that the package has received the required periodic leak testing prior to shipment, i.e., "Prior to shipping a loaded package, confirm that the periodic leak test described in Section 8.3.2.1 has been performed. For shipments of powdered radioactive materials, confirm that the most recent periodic leak test of the 8-120B cask demonstrated leaktight status." Practically, this could be accomplished by checking the tag on the package that gives the date on which the latest period leak test was performed and whether or not it was to leaktight standards. The applicant claimed that it is not practical for the user to confirm that that the most recent periodic leak test meets the requirements of Section 8.3.2.1 (i.e., confirm the test parameters that were used), but only necessary to confirm that the test was performed and whether or not it was to leaktight criteria. The staff agreed with that interpretation.

Based on these findings, the staff concludes that the operating procedures both meet the requirements of 10 CFR Part 71 and are adequate to assure the package will be operated in a manner consistent with its evaluation for approval

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

Staff reviewed the licensing basis for the containment seals. The applicant is qualifying a compound by performing extensive testing, then by doing additional physical acceptance testing on each delivered O-ring as a confirmatory measure. The O-rings are bought from a QL1 supplier, whose quality system is audited to assure that, when a compound is bought, O-rings to be procured in the future will have the same compound material on which extensive qualification testing was already done for this compound.

Section 8.3.2.1 was revised to include leak testing requirements for powdered solid shipments. Regarding the maximum specified graduation on the pressure gauge, the 0.1 psig graduation is no longer included as a requirement in Section 8.3.2.2. It is understood that the pressure gauge must be capable of measuring the pressure drop to the accuracy required to confirm that the acceptance criteria is satisfied.

CONDITIONS

The conditions specified in the Certificate of Compliance have been revised to incorporate several changes as indicated below:

Item No. 3.a has been revised to identify the new mailing address of Energy*Solutions* Products and Technology Group.

Item No. 3.b has been revised to identify Energy*Solutions*' consolidated application dated November 2013.

Condition No. 5(a)(2) has been revised to add the description of the new ½ inch thick steel plate covering the central hollow region of the lower impact limiter and change the maximum payload weight from 14,430 lbs to 14,150 lbs to offset the additional weight of the plate and maintain at the same time the maximum package weight as in previous revisions of the CoC.

Condition No. 5(a)(3) has been revised to include new revisions for Energy*Solutions* Drawing Nos. C-110-E-0007, sheets 1-6, and DWG-CSK-12CV01-EG-0001.

Condition No. 5(b)(1)(ii) has been edited to add commas for clarity purposes.

Condition No. 5(b)(2)(iii) has been revised to show a maximum payload weight of 14,430 lbs when including shoring and secondary containers.

Condition No. 7 of the previous revision of the certificate, which required two independent physical verifications of the secondary container's closure system, has been deleted. The requirements of Condition No. 7 have now been added to Chapter 7 of the application, as part of step 7.1.10 of the loading operating procedure. Since Condition No. 6 requires compliance with Chapter 7 of the application, Condition No. 7 is no longer necessary in the CoC.

Condition No. 11 of the previous revision of the certificate has been deleted. Condition No. 11 stated that a pre-shipment leak test was required before each shipment of Type B quantities. Such a wording could lead to a false interpretation of regulations for contents such as Low Specific Activity (LSA) or Surface Contaminated Object (SCO) materials as being exempted from a pre-shipment leak test. Section 7.1.14 of Chapter 7 has been revised, the note regarding exemption from pre-shipment leak testing for LSA and SCO shipments has been deleted and all shipments made with the package require pre-shipment leak testing as part of Chapter 7, Operating Procedures.

Condition No. 12 of the previous revision of the certificate was deleted. This condition is no longer applicable because the seals authorized in CoC Revision 17 are no longer permitted for use.

As a result of the deletion of Condition Nos. 7, 11, and 12, Conditions Nos. 8 through 14 of the previous certificate were renumbered. A new Condition No. 10 was added to authorize the use of the previous revision of the certificate for approximately one more year.

The expiration date of the certificate was not changed.

The references section was updated to include the consolidated application dated November 13, 2013.

CONCLUSION

Based on the statements and representations in the application, as supplemented, and the conditions listed above, the staff concludes that the Model No. 8-120B package design has been adequately described and evaluated and that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9168, Revision No. 20,
on November 22, 2013.

Section 2

Procedures

Handling Procedure for Transport Cask Model 8-120B Certificate of Compliance Number 9168

Revision 25

Authored By: Christopher S. Libert — 12-16-2013
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Reviewed By: Digitally signed by Steven Sisley Date: 2013.12.16 11:01:16 -08'00'
Steven Sisley, Cask Licensing Manager — Date

Approved By: Phillip H Thomas — 12/23/13
Phillip H. Thomas, Director – Cask Logistics — Date

- [X] Non-Proprietary
- [ ] Proprietary
- [ ] Restricted Information
- [ ] Safeguards Information
- [ ] Sensitivite Security Information

- [ ] New
- [ ] Title Change
- [X] Revision
- [ ] Rewrite
- [ ] Cancellation

Effective Date: January 1, 2014

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1.0 SCOPE

1.1 Purpose

This procedure establishes instructions for routine handling, loading, and unloading of Energy*Solutions* Cask Model 8-120B.

1.2 Applicability

This procedure applies to all Energy*Solutions* Model 8-120B Casks operated under Certificate of Compliance Number 9168 Revision 20 (see Reference 3.8).

2.0 CASK DESCRIPTION

The packaging is a carbon steel-encased, lead shielded cask with a pair of cylindrical foam-filled impact limiter installed on the cask ends. The cask is a right circular cylinder with a nominal internal cavity size of 61 13/16-inch by 74 7/8-inch high. The walls of the cask contain a minimum lead thickness of 3.35 inches encased between a 0.75-inch thick inner steel shell and a 1-1/2-inch thick outer steel shell. The exposed sides of the package (between the impact limiters) are provided with a thermal barrier consisting of a 5/32-inch diameter wire wrap on 12-inch centers and covered with 3/16-inch thick steel jacket. The secondary lid is covered with a separate, removable thermal shield. The bottom weldment is made of two, 3-1/4-inch thick carbon steel plates. The primary lid is sealed with a double o-rings and 20 equally spaced 2-inch diameter bolts. The 29-inch diameter centered secondary lid is sealed with a double o-rings and twelve equally spaced 2-inch diameter bolts. The lid sealing surfaces are stainless steel and the space between the double o-ring seals is provided with a test port for leak testing.

The top and bottom of the cask is provided with steel encased, rigid polyurethane foam impact limiters. The impact limiters are secured to each other about the cask with eight 1-inch diameter ratchet binders. The impact limiters are 102 inches in diameter and the overall height of the package with the impact limiters attached is 132 ¼ inches.

The package is provided with four tie-down and two removable lifting devices. Each lid is provided with three lifting lugs. The maximum gross weight of the packaging and contents is limited to 74,000 pounds. The approximate as-built weights[1] of the packaging components per Reference 3.7 are as follows:

Cask Weight Empty (Including Lids and Thermal Shield) ..... 49,640 pounds
- Cask Primary Lid ..... 5,200 pounds
- Cask Secondary Lid ..... 1,975 pounds
- Secondary Lid Thermal Shield ..... 250 pounds

Maximum Cask Payload (Including Shoring) ..... 13,360 pounds

Impact Limiters (each) ..... 5,500 pounds

[1] Individual component as-built weights may exceed the design weights in Reference 3.7 due to fabrication tolerances. However, the maximum weight of the payload must not exceed 13,360 pounds and the gross weight of the packaging and cask payload must not exceed 74,000 pounds. Rigging used to lift cask components must be designed to the larger of the weights above or the as-built weight indicated on the weight nameplate.

3.0 REFERENCES

3.1 CFR Title 49, Part 172

3.2 CFR Title 49, Parts 173.401-173.478

3.3 Procedure, TR-TP-002, *Air Pressure Drop Test for Model 8-120B Cask*

3.4 Procedure, CMF-RS-PR-6003, *Cask Maintenance Facility (CMF) Quality Assurance Records*

3.5 Code of Federal Regulations CFR Title 10, Part 20 and Part 71

3.6 Procedure, TR-MN-005, *Gasket/Seal/O-Ring Replacement/Repair Procedure for EnergySolutions Cask Fleet*

3.7 Transport Cask Model 8-120B Certificate of Compliance 9168

3.8 Drawing, C-110-E-0007, *8-120B Shipping Cask*

3.9 Procedure, ES-AD-PR-008, *Condition Reports*

4.0 REQUIREMENTS

4.1 Tools, Materials, Equipment - At Loading Site

4.1.1 Energy*Solutions* - Furnished Items

4.1.1.1 8-120B cask, impact limiters, tiedowns, and trailer.

4.1.1.2 8-120B cask license and documentation.

4.1.1.3 8-120B cask lid O-Rings/O-Ring Seals.

4.1.1.4 8-120B cask disposable liner, shoring, or drum pallets, if required by the shipper.

4.1.1.5 Test manifolds for performing air leak test.

4.1.2 Shipper - Furnished Items

4.1.2.1 Crane compatible with filled liner, loaded drum pallet, cask lids, and impact limiter.

4.1.2.2 Lifting hardware.

4.1.2.3 Tools

4.1.2.3.1 Calibrated torque wrenches (various sizes) that are capable of achieving the following torque values: 12, 20, 200, 250, and 500 ft.-lbs.

4.1.2.3.2 Proper size sockets with ratchets.

(a) 3/8-inch socket set.

(b) 3-1/8-inch socket, 3-inch socket, and ratchet handle.

(c) Adapters for torque wrenches

4.1.2.3.3 Small/medium adjustable wrench and open-end wrench set.

4.1.2.4 Lifting slings compatible with impact limiter and cask lids.

4.1.2.5 Acceptable bolt lubricant (Moly-Z, Neolube, or Anti-Seize).

4.1.2.6 Health Physics (HP) instrumentation and support materials.

4.1.2.7 Filling equipment for disposal liners.

4.1.2.8 Vacuum grease (for example, Parker Super-O-Lube) or petroleum jelly.

4.2 **Tools, Materials, Equipment - At Unloading Site**

4.2.1 Crane compatible with filled liner, loaded drum pallet, impact limiter, and cask lids.

4.2.2 Lifting and unloading hardware.

4.2.3 Tools

4.2.3.1 Calibrated torque wrenches (various sizes) that are capable of achieving the following torque values: 12, 20, 200, 250, and 500 ft.-lbs.

4.2.3.2 Proper size sockets with ratchet.

(a) 3/8-inch socket set

(b) 3-1/8-inch socket, 3-inch socket, and ratchet handle

(c) Adapter for torque wrenches

4.2.3.3 Small/medium adjustable wrenches and open-end wrench set.

4.2.4 Lifting sling compatible with cask lids, filled liner, and loaded drum pallets.

4.2.5 Acceptable bolt lubricant (Moly-Z, Neolube, or Anti-Seize).

4.2.6 Health Physics (HP) instrumentation and support materials.

4.2.7 8-120B cask O-Rings/O-ring seals.

4.2.8 Vacuum grease (for example, Parker Super-O-Lube) or petroleum jelly.

4.3 **Handling Precautions**

Warning: If the lid or vent port o-rings require replacement, the cask will need to be unloaded and shipped back to the Energy*Solutions* Cask Maintenance Facility (CMF) for o-ring replacement and maintenance leak testing.

4.3.1 Treat the inside of the cask, the bottom of the cask lids, and any materials removed as potentially radiologically contaminated.

4.3.2 **DO NOT** attempt to lift the cask by the lifting lugs on the impact limiter, primary cask lid, or secondary cask lid.

Caution: The cask must be lifted using the two (2) diametrically opposed primary lifting lugs that are bolted onto the cask body (Items 41, 42, and 43 of Reference 3.8). The optional redundant lifting lugs may also be used to lift the cask body, if required.

4.3.3 Survey the cask cavity for radiation and radiological contamination levels after the cask contents have been removed. Decontaminate as required by the Health Physics Department after the contents have been removed.

4.3.4 Remove any liquid or foreign materials from the cask cavity. Treat this liquid or material as potentially radiologically contaminated.

4.3.5 Visually inspect the cask for damage to the lid, impact limiter, O-Rings/seals, O-Rings/seal seating surfaces, ratchet binders, lifting lugs, lifting slings, and tie-downs.

4.3.6 When lowering a liner or pallet into cask, be alert to the possibility of airborne radiological contamination escaping the cask.

4.3.7 Visually inspect all bolts (i.e. primary and secondary lid bolts, lifting lug bolts, etc.), vent port socket head cap screw (if removed), and test port set screws for defects prior to each shipment and obtain replacements from Energy*Solutions* CMF for any parts that show cracking or other visual defects.

Caution: Only remove the cask lid vent port socket head cap screw if needing to relieve internal pressure so that the primary lid can be

removed. Use caution not to damage the vent port socket head cap screw or vent port seal.

Note: For every 8-120B cask shipment, whether or not the lid bolts or vent port socket head cap screw have been removed, the primary lid, secondary lid, and vent port seals must be leak tested prior to shipment, in accordance with Reference 3.3.

4.3.8 A packaging containing quantities of radioactive material in excess of Type "A" quantities specified in 10 CFR 20.1906(a) shall be received, monitored, and handled by the licensee receiving the package in accordance with the requirements of 10 CFR 20.1906, as applicable.

4.3.9 Before a loaded cask leaves the shipper's facility, the following shall be confirmed:

4.3.9.1 All lifting lugs are removed or properly covered for transport.

4.3.9.2 Trailer placarding and cask labeling and marking meet D.O.T. specifications (see References 3.1 and 3.2 as applicable).

4.3.9.3 Exterior radiation levels do not exceed 200 millirem per hour (2 mSv/h) on contact, 10 millirem per hour (0.1 mSv/h) at 2 meters, and 2 millirem per hour (0.02 mSv/h) in tractor cab, in accordance with 49 CFR 173.441 and 10 CFR 71.47 (see References 3.2 and 3.5).

4.3.9.4 Cask external removable contamination does not exceed Site Release Limits, 49 CFR 173.443, and 10 CFR 71.87, as applicable (see References 3.2 and 3.5).

4.3.9.5 Cask lids and vent port have been leak tested in accordance with Reference 3.3.

4.3.9.6 Cask lid bolts and vent port socket head cap screw are properly torqued.

4.3.9.7 That the cask lids and impact limiters are sealed with security seals.

4.3.9.8 That two independent physical verifications of the secondary container's closure system have been performed as part of the package loading operations to ensure that it is properly closed and secured. Record the compliance of this step in attachment 7.1, step 1.

Note: This requirement is waived for uniformly distributed resins, filters, and for solidified wastes with no dimension less than 1 cm.[2]

4.3.10 Before an empty cask leaves the shipper's facility, the following shall be confirmed:

4.3.10.1 Cask verified to be empty of radioactive waste. For foreign material exclusion concerns, cask internals must also be verified clean and clear of all non-radioactive debris.

4.3.10.2 All cask-lifting lugs are removed and properly stored with cask for transport.

4.3.10.3 Trailer placarding and cask labeling and marking meet D.O.T. specifications (see References 3.1 and 3.2 as applicable).

4.3.10.4 Exterior radiation levels do not exceed limits per 49 CFR 173.441 and 10 CFR 71.47 (see References 3.2 and 3.5).

4.3.10.5 Cask internal and external removable contamination does not exceed Site Release Limits, 49 CFR 173.428, 49 CFR 173.443, and 10 CFR 71.87, as applicable (see References 3.2 and 3.5).

4.3.10.6 Cask lid bolts and vent port socket head cap screw are properly torqued.

4.3.10.7 That the cask lids and impact limiters are sealed with security seals.

4.3.11 The inspection tag attached to the primary or secondary lid shall be reviewed to verify none of the maintenance, inspection or testing activities has passed the due dates recorded on the tag. If any dates have expired, or will expire prior to the cask reaching the destination where it will be unloaded, Energy*Solutions* CMF shall be contacted.

[2] The basis for double verification is to assure that small, high-specific activity particles do not have the potential to migrate up into the annular gap between the primary lid and the cask bolting flange. Payloads containing any form of isotope sources, or containing highly activated fines, swarf, crud, or other hot particles less than 1 cm in size are therefore not exempt.

4.3.12 Use of impact wrenches to remove cask lid bolts is limited to breaking initial torque on the bolt. Once the bolt is free to rotate, further removal of bolt with impact wrench shall stop. Final removal of lid bolts is to be done by hand.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to remove the bolts.

4.3.13 Impact wrenches should not be used for the installation of the cask lid bolts; bolts should be installed and hand-tightened then torqued using a star pattern.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to install the bolts.

4.3.14 Flammable gas (hydrogen) concentration is limited to less than 5% in volume. Compliance with this concentration limit is determined by the methodology used in NUREG/CR-6673.

Note: For any package containing materials with radioactive concentrations not exceeding that for LSA material, ensure that the shipment occurs within 10 days of preparation or 10 days of venting the loaded secondary container.

4.4 **Acceptance Criteria**

4.4.1 The package has been prepared for shipment per this handling procedure and the requirements of Reference 3.7.

4.4.2 Air pressure drop leak tests have been satisfactorily performed prior to release of the cask for shipment in accordance with Reference 3.3.

Note: The presence of a security seal on the lids does not imply that leak testing has been previously performed or is not required. Energy*Solutions* requires leak testing of the cask lids and vent port prior to every shipment.

5.0 DETAILED PROCEDURE

Note: Prior to loading the cask, the payload must be qualified in accordance with the requirements of Reference 3.7. The maximum decay heat of the contents shall not exceed 200 watts. The maximum payload weight must not exceed 13,360 pounds, nor result in a maximum packaging weight exceeding 74,000 pounds. The maximum quantity of material in the contents shall be limited per Reference 3.7.

Note: Prior to loosening the impact limiter ratchet binders, inspect the exterior of the package for damage, e.g., large dents, gouges, tears to the impact limiter skin and thermal shield. Contact Energy*Solutions* CMF if damage is present. The cask may not be used as a Type B package until the damage is assessed by Energy*Solutions* CMF and repairs, if required, are made to achieve conformance with Reference 3.7.

Note: Steps of this procedure in Section 5.0 may be performed in non-sequential order.

5.1 Loading Procedure

Note: If it is necessary to remove the cask from the trailer, refer to Section 5.3.

5.1.1 Prepare to Load the Cask

Warning: Treat the underside of the lids, the inside surfaces of the cask, and any bolts or seals removed as potentially radiologically contaminated.

Note: The cask may be loaded using either pallets, or a liner processed through either the primary or secondary lid. Follow Step 5.1.2 for loading pallets. Follow Step 5.1.3 for loading a liner through the primary lid. Follow Step 5.1.4 for processing liner through secondary lid.

5.1.2 Procedure for Loading Pallets

5.1.2.1 Remove upper impact limiter.

Note: Position cask and trailer on a level surface (visual determination) to facilitate impact limiter and lid removal.

5.1.2.1.1 Remove the security seal. Properly dispose of removed seal.

5.1.2.1.2 Remove impact limiter lifting lug covers.

5.1.2.1.3 Loosen ratchet binders securing impact limiter.

5.1.2.1.4 Remove holding pin and bolt from upper end of ratchet binder. Retain bolts and holding pins for reinstallation.

Note: Do not lose the ratchet binder holding pins.

5.1.2.1.5 Attach crane to lifting lugs on upper impact limiter using appropriate lifting gear.

5.1.2.1.6 Ensure alignment marks are on impact limiter and cask body.

Caution: To prevent damage to the impact limiter, place impact limiter carefully in set-down area.

5.1.2.1.7 Lift off impact limiter.

5.1.2.2 Remove Secondary Lid Thermal Shield

5.1.2.2.1 Remove the ball lock pins from each of the three retaining pins and remove the retaining pins from the secondary lid lift lugs.

5.1.2.2.2 Using suitable lifting equipment, remove the secondary lid thermal shield. Care should be taken to prevent damage to the thermal shield during handling and storage.

5.1.2.3 Remove primary cask lid.

5.1.2.3.1 Prior to removing the cask primary lid, the inspection tag attached to the primary or secondary lid shall be reviewed to verify none of the maintenance, inspection or testing activities has passed the due dates recorded on the tag. If no tag is present, or if any dates have expired, or will expire prior to the cask reaching the destination where it will be unloaded, Energy*Solutions* CMF shall be contacted prior to proceeding.

Note: Contact Energy*Solutions* CMF for further directions if no inspection tag is present, or if any of the due dates on the inspection tag have expired or will expire prior to unloading the cask.

5.1.2.3.2 Remove the security seals. Properly dispose of removed seals.

Caution: Use of impact wrenches to remove cask lid bolts is limited to breaking initial torque on the bolt. Once the bolt is free to rotate, stop using impact wrench. Final removal of lid bolts is to be done by hand.

5.1.2.3.3 Loosen and remove the twenty (20) 2-inch hex head bolts from the primary cask lid, using a star pattern. Do not leave bolts in lid during removal. Retain them for reinstallation.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to install and remove the bolts.

5.1.2.3.4 Attach crane hook to primary lid lifting lugs using appropriate lifting hardware.

Note: The cables used to lift the primary lid must have a true angle of not less than 45° with respect to the horizontal.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

5.1.2.3.5 Slowly raise the cask lid to clear cask and set the lid down on absorbent material or plastic sheeting, if required.

Warning: Treat the underside of the lid, the inside surfaces of cask, and any bolts or seals removed as potentially radiologically contaminated.

5.1.2.3.6 Visually inspect the cask lid bolts for defects and obtain replacement bolts from Energy*Solutions* CMF for any lid bolts that show cracking or other visual defects. Lubricate bolt threads, if required.

5.1.2.3.7 Visually inspect lid bolt holes for damage, defects and accumulation of debris. Remove debris, if required. Contact Energy*Solutions* CMF for any

bolt holes that show signs of cracking or visual signs of distress.

5.1.2.3.8 Visually inspect and clean the O-Ring seating surfaces.

5.1.2.4 Remove the contents of the cask.

Warning: Treat the pallets as potentially radiologically contaminated items.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

5.1.2.4.1 Attach the crane hook to the pallet lifting ring.

5.1.2.4.2 Lifting the pallet straight up out of the cask and place it on absorbent material or plastic sheeting, if required.

5.1.2.4.3 Remove the crane hook.

5.1.2.4.4 Repeat Steps 5.1.2.4.1 through 5.1.2.4.3 as necessary to remove both pallets from the cask.

Warning: Radioactively contaminated liquids may be pumped out or removed by use of an absorbent material. Removal of any material from inside the cask shall be performed under the supervision of qualified health physics personnel with the necessary H.P. monitoring and radiological health safety precautions and safeguards.

5.1.2.4.5 Visually inspect the interior of the cask for any damage or defects that may affect the integrity of the cask or shielding provided by the cask. Also inspect for loose materials or moisture. Report any noted damage or defects to Energy*Solutions* CMF for resolution before proceeding with cask loading. Remove any liquids or foreign materials from the cask cavity.

5.1.2.5 Load the pallet into the cask.

Caution: Do not place the drums on the pallet lifting sling.

Caution: Confirm that the safety hook (if installed) on the pallet sling remains attached to the lifting ring.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces

Warning: Treat all debris removed from the pallet as potentially radiologically contaminated.

5.1.2.5.1 Clean each pallet before loading it. Load each pallet with a maximum of four 55-gallon drums, or equivalent.

5.1.2.5.2 Perform two independent physical verifications of each secondary container's closure system to ensure that it is properly closed and secured. Record the compliance of this step in attachment 7.1, step 1.

Note: This requirement is waived for uniformly distributed resins, filters, and for solidified wastes with no dimension less than 1 cm.

5.1.2.5.3 Attach the crane hook to the pallet lifting ring.

5.1.2.5.4 Carefully lift the pallet and place into the cask. Detach the crane hook and place pallet lifting ring on top of drums. DO NOT damage the inside of the cask.

Note: Shore drums if necessary to limit movement during normal transport conditions.

5.1.2.5.5 Repeat Steps 5.1.2.5.1 through 5.1.2.5.4 to load other pallet into the cask.

5.1.2.6 Replace the primary lid.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

Note: Confirm that the bolts on the secondary lid are torqued to a lubricated value of 500 ± 50 ft.-lbs (refer to Steps 5.1.4.4.6 through 5.1.4.4.8 for torquing bolts), before the cask leaves the facility. Bolt torque does not have to be checked on bolts with security seals.

5.1.2.6.1 Attach the lifting sling to the three (3) lifting lugs on the primary lid.

Note: The cables used to lift the primary lid must have a true angle of not less than 45° with respect to the horizontal.

5.1.2.6.2 Attach the crane hook to the lifting sling.

5.1.2.6.3 The primary lid O-Ring seals shall be visually inspected for serviceability ensuring that they are in the proper position and free of cracks, tears, cuts or discontinuities which may prevent them from sealing properly. The seal seating surface shall be visually inspected to ensure that they are free of damage, debris, gravel, or any foreign matter, which might damage the seals or prevent the seals from properly sealing. If any defects are detected, that may prevent the seals from forming a seal contact Energy*Solutions* CMF. Refer to the provisions of Step 4.4.2 for leak test requirements. Inspect and clean the O-Ring seating surfaces. A very thin coat of vacuum grease or petroleum jelly should be applied to the sealing surface of the O-Ring prior to installing and torquing the lid. Inspect the air test annulus and leak test port to assure that they are free of foreign materials (i.e. silicone, vacuum grease, petroleum jelly, etc.).

Warning: Treating all debris removed from the bottom surface of the lid as potentially radiologically contaminated.

5.1.2.6.4 Lift the primary lid, clean the bottom surface, and lower into position using alignment marks and alignment pins.

Caution: The use of impact wrenches for the installation of cask lid bolts is not permitted.

5.1.2.6.5 Replace and hand tighten the twenty (20) 2-inch hex head primary lid bolts.

Note: Tighten all the bolts hand-tight before starting torque sequence.

5.1.2.6.6 Torque all the bolts to 250 ± 25 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 250 ± 25 ft. lbs., repeating the star pattern.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to install the bolts.

5.1.2.6.7 Re-torque all the bolts to 500 ± 50 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 500 ± 50 ft. lbs., repeating the star pattern.

5.1.2.6.8 Check torque on all bolts, at least once, using a circular pattern to 500 ± 50 ft.-lbs.

Note: Start torque at the same start bolt used in Step 5.1.2.6.7

5.1.2.6.9 Torque the vent port socket head cap screw to 20 ± 2-ft. lbs.

Note: If the vent port socket head cap screw is removed, the O-ring Seal shall be inspected and replaced, if damaged. Prior to installation, the O-ring Seal shall be installed on the vent port socket head cap screw; and a thin layer of anti-seize should be applied to the vent port socket head cap screw threads.

5.1.2.6.10 Leak test the cask primary lid, secondary lid and vent port per Reference 3.3.

5.1.2.6.11 After completing the leak tests in accordance with Reference 3.3, ensure all 3 test port set screw plugs are in place.

5.1.2.6.12 Seal the primary lid with security seals.

5.1.2.6.13 Ensure that all dirt/clay/debris is removed from the cask lids prior to installation of the cask impact limiters.

5.1.2.7 Replace secondary lid thermal shield and upper impact limiter.

Caution: Ensure inner surfaces of impact limiter are below external package limits as specific in Reference 3.2. Also, this

should include any enclosed surfaces of external cask body.

5.1.2.7.1 Using suitable lifting equipment, lift, inspect for damage and install the secondary lid thermal shield. Contact Energy*Solutions* CMF if any damage is present.

5.1.2.7.2 Install the three secondary lid thermal shield retaining pins into the secondary lid lift lugs and insert the ball lock pins into the retaining pins.

5.1.2.7.3 Attach the crane hook to the lifting lugs on the impact limiter and lift it; inspect for damage.

5.1.2.7.4 Position the impact limiter on cask using alignment marks on the cask body and impact limiter.

5.1.2.7.5 Replace the bolts in the ratchet binders.

Note: Visually inspect ratchet binder bolts for signs of cracking or other visual defects. Replace any defective materials. Contact Energy*Solutions* CMF prior to replacing any defective materials.

5.1.2.7.6 Insert holding pins. Tighten the ratchet binders hand tight and return the ratchet handles to their storage position leaving the flip block in the on/tighten position.

5.1.2.7.7 Place security seals on the impact limiter or ratchet handles.

5.1.2.7.8 Install impact limiter lifting lug covers.

5.1.3 Procedure for Loading Liner into Cask

Note: If the liner is pre-filled, confirm that it has been capped using standard capping devices.

Note: If the cask contains an empty, unused liner, the liner may be filled by removing only the secondary lid. Refer to Section 5.1.4 for processing a liner through the secondary lid.

5.1.3.1 Remove upper impact limiter and secondary lid thermal shield. Follow Steps 5.1.2.1 through 5.1.2.2.2.

5.1.3.2 Remove primary cask lid. Follow Steps 5.1.2.3 through 5.1.2.3.8.

Caution: Care should be taken during liner handling operations to prevent damage to cask sealing surfaces.

5.1.3.3 Load the liner into the cask.

Warning: As the liner is lowered into the cask, the air in the cask will cushion and slow the liner. Be alert to the possibility of radiological airborne contamination escaping from the cask during this operation.

5.1.3.3.1 Visually inspect the interior of the cask for any defects which may affect the integrity of the cask or shielding provided by the cask. Also inspect for loose material or moisture. Report any noted defects to Energy*Solutions* CMF for resolution before proceeding with the cask loading. Remove any liquids or foreign materials from the cask cavity.

Caution: Radioactively contaminated liquids may be pumped out or removed by use of an absorbent material. Removal of any material from inside the cask shall be performed under the supervision of qualified Health Physics personnel with the necessary H.P. monitoring and radiological health safety precautions and safeguards.

5.1.3.3.2 Inspect and clean, if required, the external surfaces of the liner before placing it in the cask.

Warning: Treat all debris removed from the liner as potentially radiologically contaminated.

5.1.3.3.3 Perform two independent physical verifications of the liner's closure system to ensure that it is properly closed and secured. Record the compliance of this step in attachment 7.1, step 1.

Note: This requirement is waived for uniformly distributed resins, filters, and for solidified wastes with no dimension less than 1 cm.

5.1.3.3.4 Attach the crane hook to the cables or grapple ring on the liner and lift the liner.

Caution: Care should be taken during liner handling operations to prevent damage to cask or lid seal surfaces.

5.1.3.3.5 Lower the liner straight into cask.

5.1.3.3.6 Detach crane hook from the cables or grapple ring on the liner.

5.1.3.3.7 Ensure that liner lifting cables lay flat to allow proper installation of the cask lid.

Note: Shore the liner, if necessary, to prevent movement during normal transport conditions.

5.1.3.4 Replace primary cask lid. Follow Steps 5.1.2.6 through 5.1.2.6.13.

5.1.3.5 Replace secondary lid thermal shield and upper impact limiter. Follow Steps 5.1.2.7 through 5.1.2.7.8.

5.1.4 Procedure for Processing Liner through Secondary Lid

5.1.4.1 Remove upper impact limiter and secondary lid thermal shield. Follow Steps 5.1.2.1 through 5.1.2.2.2.

5.1.4.2 Remove secondary cask lid.

5.1.4.2.1 Prior to removing the cask secondary lid, the inspection tag attached to the primary or secondary lid shall be reviewed to verify none of the maintenance, inspection or testing activities have passed the due dates recorded on the tag. If no tag is present, or if any dates have expired, or will expire prior to the cask reaching the

destination where it will be unloaded, Energy*Solutions* CMF shall be contacted prior to proceeding.

Note: **Contact Energy*Solutions* CMF for further directions if no inspection tag is present, or if any of the due dates on the inspection tag have expired or will expire prior to unloading the cask.**

5.1.4.2.2 Remove the security seals. Properly dispose of removed seals.

Caution: **Use of impact wrenches to remove cask lid bolts is limited to breaking initial torque on the bolt. Once the bolt is free to rotate, stop using impact wrench. Final removal of lid bolts is to be done by hand.**

5.1.4.2.3 Loosen and remove the twelve (12) 2-inch bolts from the secondary lid. Do not leave bolts in lid during removal.

Note: **Pneumatic or hydraulic torque wrenches (non-impacting) may be used to remove the bolts.**

5.1.4.2.4 Attach crane hook to secondary lid lifting lugs, using appropriate lifting hardware.

Note: **The cables used to lift the secondary lid must have a true angle of not less than 45° with respect to the horizontal.**

Caution: **Care should be taken during handling operation to prevent damage to cask sealing surfaces.**

5.1.4.2.5 Slowly remove secondary lid from cask and place it on absorbent material or plastic sheeting, if required.

Warning: **Treat the underside of the lid, the inside surfaces of cask, and any bolts or seals removed as potentially radiologically contaminated.**

5.1.4.2.6 Visually inspect the secondary lid bolts for defects and obtain replacement bolts from Energy*Solutions* CMF for any lid bolts that show cracking or other visual defects. Lubricate bolt threads, if required.

5.1.4.2.7 Visually inspect lid bolt holes for damage, defects and accumulation of debris. Remove debris, if required. Contact Energy*Solutions* CMF for any bolt holes that show signs of cracking or visual signs of distress.

5.1.4.2.8 Visually inspect and clean the O-Ring seating surfaces.

5.1.4.3 Process liner as necessary, and cap using standard capping devices.

5.1.4.4 Perform two independent physical verifications of the liner's closure system to ensure that it is properly closed and secured. Record the compliance of this step in attachment 7.1, step 1.

Note: This requirement is waived for uniformly distributed resins, filters, and for solidified wastes with no dimension less than 1 cm.

5.1.4.5 Replace secondary lid.

5.1.4.5.1 Attach crane and lifting sling to lifting lugs on secondary lid.

Note: The cables used to lift the secondary lid must have a true angle of not less than 45° with respect to the horizontal.

5.1.4.5.2 The secondary lid O-Ring seals shall be visually inspected for serviceability ensuring that they are in the proper position and free of cracks, tears, cuts or discontinuities which may prevent them from sealing properly. The seal seating surface shall be visually inspected to ensure that they are free of damage, debris, gravel, or any foreign matter, which might damage the seals or prevent the seals from properly sealing. If any defects are detected, that may prevent the seals from forming a seal contact Energy*Solutions* CMF. Refer to the provisions of Step 4.4.2 for leak test requirements.

Inspect and clean the O-Ring seating surfaces. A very thin coat of vacuum grease or petroleum jelly should be applied to the sealing surface of the O-Ring prior to installing and torquing the lid. Inspect the air test annulus and leak test port to assure that they are free of foreign materials (i.e. silicone, vacuum grease, petroleum jelly, etc.).

Warning: Treat all debris removed from the bottom surface of the lid as potentially radiologically contaminated.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

5.1.4.5.3 Place secondary lid on cask using alignment marks and/or alignment pins.

5.1.4.5.4 Visually inspect secondary cask lid bolts for defects and obtain replacement bolts from Energy*Solutions* CMF for any bolts that show cracking or other visual defects. Lubricate bolt threads, if required.

Caution: The use of impact wrenches for the installation of cask lid bolts is not permitted.

5.1.4.5.5 Replace and hand tighten the twelve (12) 2-inch bolts.

Note: Tighten all bolts hand-tight before starting torque sequence. If Energy*Solutions* security seals on primary lid are intact, removal of primary lid for O-Ring inspection is not required. Bolt torque does not have to be checked on bolts with security seals.

5.1.4.5.6 Torque all the bolts to 250 ± 25 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 250 ± 25 ft, lbs., repeating the star pattern.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to install the bolts.

5.1.4.5.7 Re-torque all the bolts to 500 ± 50 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 500 ± 50 ft. lbs., repeating the star pattern.

5.1.4.5.8 Check torque on all bolts, at least once, using a circular pattern to 500 ± 50 ft.-lbs. Do not leave bolts in lid during removal.

Note: Start torque at the same start bolt used in Step 5.1.4.4.7.

5.1.4.5.9 Torque the vent port socket head cap screw to 20 ± 2-ft. lbs.

Note: If the vent port socket head cap screw is removed, the vent port seal shall be inspected, if damaged contact Energy*Solutions* CMF. Prior to installation, the vent port seal shall be installed on the vent port socket head cap screw; and a thin layer of anti-seize should be applied to the vent port socket head cap screw threads.

5.1.4.5.10 Leak test the cask primary lid, secondary lid and vent port o-ring seals per Reference 3.3.

5.1.4.5.11 After completing reference 3.3, ensure all 3 test port set screw plugs are in place.

5.1.4.5.12 Place security seals on secondary lid.

5.1.4.5.13 Ensure that all dirt/clay/debris is removed from the cask lids prior to installation of the cask impact limiters.

5.1.4.5 Replace secondary lid thermal shield and upper impact limiter. Follow Steps 5.1.2.7 through 5.1.2.7.8.

5.1.5 Inspect the cask tie-down cables for tightness. Tighten if necessary.

5.1.6 Before the loaded cask leaves the shipper's facility, the following shall be confirmed:

5.1.6.1 Trailer placarding and cask labeling and marking meet D.O.T. specifications in References 3.1 and 3.2 as applicable.

5.1.6.2 That exterior radiation levels do not exceed 200 millirem per hour (2 mSv/h) on contact, 10 millirem per hour (0.1 mSv/h) at 2 meters, and 2 millirem per hour (0.02 mSv/h) in the tractor cab, in accordance with 49 CFR 173.441 and 10 CFR 71.47 (see References 3.2 and 3.5).

5.1.6.3 That cask external removable contamination does not exceed Site Release Limits, 49 CFR 173.443 and 10 CFR 71.87, as applicable (see Reference 3.2 and 3.5).

5.1.6.4 Cask primary lid, secondary lid, and vent port o-ring seals have been air pressure drop leak tested in accordance with Reference 3.3.

5.1.6.5 Cask lid bolts and vent port socket head cap screw are properly torqued.

5.1.6.6 That the cask lids and impact limiters are sealed with security seals.

5.1.6.7 That all lifting lugs are removed or properly covered for transport.

5.1.6.8 Inspect the accessible exterior surfaces of the package for damage (e.g., large dents, gouges and/or tears in the impact limiter skin or thermal shielding.) Contact Energy*Solutions* CMF if damage is identified.

5.1.6.9 Two independent physical verifications of the secondary container's closure system have been performed as part of the package loading operations to ensure that it is properly closed and secured. Record the compliance of this step in attachment 7.1, step 1.

Note: This requirement is waived for uniformly distributed resins, filters, and for solidified wastes with no dimension less than 1 cm.

5.1.6.10 The periodic leak test of the primary lid, secondary lid, and vent port plug o-ring seals has been performed in the prior 12-month period. For a shipment of powdered radioactive materials (i.e., powdered solids), confirm that the most recent periodic leak test demonstrated leaktight status.

5.1.7 Complete the USER CHECK-OFF SHEET (Attachment 7.1) or equivalent sheet and send a copy with the shipment.

5.2 **Unloading Procedure**.

Note: Verify compliance to Step 4.3.8.

Note: If it is necessary to remove the cask from the trailer, refer to Section 5.3 of this procedure.

Warning: All personnel handling a filled liner or filled drums shall observe established site radiation protection procedures

5.2.1 Move the unopened package to an appropriate level unloading area; and position the unloading crane at an optimum distance to facilitate offloading the cask and minimizing operator exposure.

5.2.2 Remove upper impact limiter and secondary lid thermal shield.

Note: Position cask and trailer on a level surface (visual determination) to facilitate impact limiter and lid removal.

5.2.2.1 Perform an external examination of the unopened package. Record any significant observations.

5.2.2.2 Remove the impact limiter security seals. Properly dispose of removed seals.

5.2.2.3 Remove impact limiter lifting lug covers.

5.2.2.4 Loosen ratchet binders securing impact limiter.

5.2.2.5 Remove holding pin and bolt from upper end of ratchet binder. Retain bolts and holding pins for reinstallation.

Note: Do not lose the ratchet binder holding pins.

5.2.2.6 Attach crane to lifting lugs on upper impact limiter using appropriate lifting gear.

5.2.2.7 Ensure alignment marks are on impact limiter and cask body.

5.2.2.8 Lift off impact limiter.

Caution: To prevent damage to the impact limiter, place impact limiter carefully in set-down area.

5.2.2.9 Remove the ball lock pins from each of the three retaining pins and remove the retaining pins from the secondary lid lift lugs.

5.2.2.10 Using suitable lifting equipment, inspect for damage, and remove the secondary lid thermal shield. Contact Energy*Solutions* CMF if damage is present. Care should be taken to prevent damage to the thermal shield during handling and storage.

5.2.3 Remove primary cask lid.

Warning: Treat the underside of the lids, the inside surfaces of the cask, and any bolts or seals removed as potentially radiologically contaminated.

5.2.3.1 Remove security seals. Properly dispose of removed seals.

Caution: Use of impact wrenches to remove cask lid bolts is limited to breaking initial torque on the bolt. Once the bolt is free to rotate, stop using impact wrench. Final removal of lid bolts is to be done by hand.

5.2.3.2 Loosen and remove the twenty (20) 2-inch hex head bolts from the primary cask lid, using a star pattern. Do not leave bolts in lid during removal. Retain them for reinstallation.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to remove the bolts.

5.2.3.3 Attach crane hook to lifting lugs on primary cask lid using appropriate lifting hardware.

Note: The cables used to lift the primary lid must have a true angle not less than 45° with respect to the horizontal.

Caution: Use care during handling operations to prevent damage to cask sealing surfaces.

5.2.3.4 Slowly raise the cask lid to clear cask and set the lid down on absorbent material or plastic sheeting, if required.

Warning: Treat the underside of the lid, the inside surfaces of cask, and any bolts or seals removed as potentially radiologically contaminated.

5.2.3.5 Visually inspect the cask lid bolts for defects and obtain replacement bolts from Energy*Solutions* CMF for any lid bolts that show cracking or other visual defects. Lubricate bolt threads, if required.

5.2.3.6 Visually inspect lid bolt holes for damage, defects and accumulation of debris. Remove debris, if required. Contact Energy*Solutions* CMF for any bolt holes that show signs of cracking or visual signs of distress.

5.2.3.7 Visually inspect and clean the O-Ring seating surfaces.

5.2.4 The Health Physics Technician shall conduct a radiation survey to determine offloading precautions.

5.2.5 If directed by the Health Physics Technician, vacate all personnel from the immediate area except for the crane operator and rigger. The rigger shall stand in clear view of the crane operator or have proper communications with crane operator.

5.2.6 Prepare to remove contents of the cask.

Note: The cask may contain a filled liner or pallets. If the cask contains pallets, follow the procedure for unloading pallets, Step 5.2.8 and skip Step 5.2.7.

5.2.7 Procedure for Unloading a Liner

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

5.2.7.1 Attach crane hook to the cables or grapple ring on the liner.

5.2.7.2 Lift liner straight up out of cask and allow any liquid to drip off into the cask.

5.2.7.3 Place the liner in position for disposal or future handling.

5.2.8 Procedure for Unloading Pallets

Caution: Confirm that the safety hook (if installed) on the pallet sling remains attached to the lifting ring.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

5.2.8.1 Attach crane hook to the pallet lifting ring.

5.2.8.2 Lift pallet straight up out of cask.

5.2.8.3 Position the pallet for disposal or future handling.

5.2.8.4 Empty the pallet.

Warning: Treat all materials removed from the pallet as potentially radiologically contaminated.

5.2.8.5 Recover pallet for reuse. Clean and decontaminate the pallet, if necessary. Detach the crane hook.

5.2.8.6 Repeat Steps 5.2.8 through 5.2.8.5 to remove and empty the other pallet from the cask.

5.2.9 The Health Physics Technician shall survey the interior of the cask for radiation and contamination levels. Decontaminate if acceptable levels (as per Site procedures) are exceeded.

Warning: Treat any liquid in the cask or used in decontamination process as potentially radiologically contaminated.

Warning: Radioactively contaminated liquids may be pumped out or removed by use of an absorbent material. Removal of any material from inside the cask shall be performed under the supervision of qualified Health Physics personnel with the necessary H.P. monitoring and radiological health safety precautions and safeguards.

5.2.10 Visually inspect the inside of the cask for damage, foreign materials, or liquid accumulation. If the interior surfaces of the cask are damaged, remove the cask from service and report any noted defects to Energy*Solutions* CMF before proceeding with cask operations. Contact Health Physics Department for instructions on removal of any liquids or foreign materials from the cask cavity.

Caution: Care should be taken during liner handling operations to prevent damage to cask sealing surfaces.

5.2.11 Place a new liner in the cask, if required. The liner cables should be taped on the liner to ensure the cables do not interfere with installing the HIC lid. Reload the pallets into the cask, if required.

Note: Load only one pallet at a time.

Warning: Treat any material removed from the bottom of the liner or pallets as potentially radiologically contaminated.

5.2.11.1 Attach crane hook to slings on liner, the grapple ring on the liner, or to the lifting ring on the pallet and slowly lift the liner or pallet. Clean the bottom of the liner or pallet before placing it into the cask.

Caution: <u>Do not</u> damage the O-Ring seating surfaces, the sides of the cask, or inner walls.

5.2.11.2 Carefully lower the liner or pallet into the cask and detach the crane hook.

5.2.11.3 Repeat Steps 5.2.11 and 5.2.11.2 to place other pallet into cask.

5.2.12 Replace primary lid.

Note: If the secondary lid is not sealed with a proper Energy*Solutions* security seal, the secondary lid shall be removed for inspection of O-Rings and seating surfaces prior to reinstalling the primary lid on the cask body or may be performed after primary lid is replaced on cask body. Refer to Steps 5.1.4.2.1 through 5.1.4.2.8 for secondary lid removal. After lid removal refer to Steps 5.1.4.4.1 through 5.1.4.4.13 for replacement of secondary lid.

5.2.12.1 Attach the crane hook to the three (3) lifting lugs on the primary lid.

Note: The cables used to lift the primary lid must have a true angle of not less than 45° with respect to the horizontal.

5.2.12.2 The primary lid O-Ring seals shall be visually inspected for serviceability ensuring that they are in the proper position and free of cracks, tears, cuts or discontinuities which may prevent them from sealing properly. The seal seating surface shall be visually inspected to ensure that they are free of damage, debris, gravel, or any foreign matter, which might damage the seals or prevent the seals from properly sealing. If any defects are detected, that may prevent the seals from forming a seal, contact Energy*Solutions* CMF. Inspect and clean the O-Ring seating surfaces. A very thin coat of vacuum grease or petroleum jelly should be applied to the sealing surface of the O-Ring prior to installing and torquing the lid. Inspect the air test annulus and leak test port to assure that they are free of foreign materials (i.e. silicone, vacuum grease, petroleum jelly, etc.).

Warning: Treat all debris removed from the bottom surface of the lid as potentially radiologically contaminated.

5.2.12.3 Clean the bottom surface of the lid and inspect lid bolt holes for damage and accumulation of debris. Remove debris, if required.

5.2.12.4 Visually inspect and clean O-Ring seating surfaces for any damage or material that will prevent O-Rings from forming a seal. If inspection is satisfactory apply a very thin coat of vacuum grease or petroleum jelly. Contact Energy*Solutions* CMF if any damage, nicks, gauges or anything that might interfere with the o-rings sealing properly.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

5.2.12.5 Visually inspect the cask lid bolts for defects and obtain replacement for any bolts that show cracking or other visual defects. Lubricate bolt threads, if required and Visually inspect lid bolt holes for damage, defects and accumulation of debris. Remove debris, if required. Contact Energy*Solutions* CMF for any bolt holes that show signs of cracking or visual signs of distress.

Note: To more easily seat primary lid; after positioning lid within guide pins approximately 1 inch above cask body, start threading each of the 20 bolts by hand. Once all bolts have been started, clear the area and slowly place the lid onto the cask body.

5.2.12.6 Lift the primary lid and lower onto the cask and position using alignment marks and alignment pins.

5.2.12.7 Replace and hand tighten the twenty (20) 2-inch primary lid bolts.

Note: Tighten all the bolts hand-tight before starting the torque sequence.

Caution: The use of impact wrenches for the installation of cask lid bolts is not permitted.

5.2.12.8 Torque all bolts to 250 ± 25 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 250 ± 25 ft. lbs., repeating the star pattern.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to install the bolts.

5.2.12.9 Re-torque all bolts to 500 ± 50 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 500 ± 50 ft. lbs., repeating the star pattern.

5.2.12.10 Check torque on all bolts, at least once, using a circular pattern to 500 ± 50 ft.-lbs. If any bolts move, go back to step 5.2.12.9.

Note: Start torque at the same start bolt used in Step 5.2.12.9.

5.2.12.11 Torque the vent port socket head cap screw to 20 ± 2-ft. lbs.

Note: If the vent port socket head cap screw is removed, the vent port seal shall be inspected, if damaged contact Energy*Solutions* CMF. Prior to installation, the vent port seal shall be installed on the vent port socket head cap screw; and a thin layer of anti-seize should be applied to the vent port socket head cap screw threads.

5.2.12.12 Seal the primary lid with security seals.

5.2.12.13 Ensure that all dirt/clay/debris is removed from the cask lids prior to installation of the cask impact limiter.

5.2.13 Replace secondary lid thermal shield and upper impact limiter.

Warning: Ensure inner surfaces of impact limiter are below external package limits as specified in Reference 3.2 and/or site release limits. Also, this should include any enclosed surfaces of external cask body.

5.2.13.1 Using suitable lifting equipment, lift, inspect for damage and install the secondary lid thermal shield. Contact Energy*Solutions* CMF if damage is present.

5.2.13.2 Install the three secondary lid thermal shield retaining pins into the secondary lid lift lugs and insert the ball lock pins into the retaining pins.

5.2.13.3 Attach the crane hook to the lifting lugs on the impact limiter; lift it, and inspect for damage.

5.2.13.4 Position the impact limiter on cask using alignment marks on the cask body and impact limiter and detach the crane hook.

Note: Visually inspect ratchet binder bolts for any signs of cracking or other visual defects. Replace any defective bolts or pins.

5.2.13.5 Replace the top bolts in the ratchet binders. Insert holding pins.

Note: Tools, wrenches, pipes ect. are not permitted to be used on any cask ratchet binder. Using these tools will cause damage to ratchet binders.

5.2.13.6 Tighten the ratchet binders hand tight and return ratchet handles to storage position leaving flip block in the lock position.

5.2.13.7 Place security seals on the impact limiter.

5.2.13.8 Install impact limiter lifting lug covers.

5.2.14 Inspect the cask tie-down cables for tightness. Tighten if necessary.

5.2.15 The Health Physics Technician shall survey all exterior surfaces of the cask for contamination and radiation levels. Decontaminate, as required, to meet the limits set in Site radiation and contamination release procedures and Reference 3.2.

5.2.16 Before the empty cask leaves the shipper's facility, the following shall be confirmed:

5.2.16.1 Cask verified to be empty of radioactive waste. For foreign material exclusion concerns, cask internals must also be verified clean and clear of all non-radioactive debris.

5.2.16.2 Cask internal and external removable contamination does not exceed Site Release Limits, 49 CFR 173.428, 49 CFR 173.443, and 10 CFR 71.87, as applicable (see References 3.2 and 3.5).

5.2.16.3 The cask lid bolts and vent port socket head cap screw are properly torqued.

5.2.16.4 Trailer placarding and cask labeling and marking meet D.O.T. specifications in References 3.1 and 3.2 as applicable.

5.2.16.5 That radiation levels conform to requirements as established in Site radiation and contamination release procedures, 49

CFR 173.441 and, and 10 CFR 71.47, as applicable (see References 3.2 and 3.5).

5.2.16.6 That the cask lids and impact limiters are sealed with security seals.

5.2.16.7 That all lifting lugs are removed or properly covered for transport.

5.3 **Removing the Cask from the Trailer**

Note: Removal of cask from trailer is usually not necessary. Authorization to remove cask from trailer must be granted on a case by case basis. If removal is necessary, authorization may be obtained from Energy*Solutions* CMF.

5.3.1 Locate the trailer.

5.3.1.1 Position the trailer and cask within reach and safe load limit of the crane.

5.3.1.2 Be sure the trailer is level (visual determination).

5.3.2 Loosen and remove the cask tie-down cables.

5.3.3 Prepare the cask for removal from the trailer.

5.3.3.1 Be aware that the cask must be set back into place using the alignment marks on the bottom impact limiter and cask body.

5.3.3.2 Remove upper impact limiter and secondary lid thermal shield. Follow Steps 5.1.2.1 through 5.1.2.2.2.

5.3.3.3 Check torque on primary and secondary lid bolts and ensure all bolts are torqued to 500 ± 50 ft.-lbs., using a star pattern. Bolt torque does not have to be checked on bolts with security seals.

5.3.3.4 Remove cask lifting lugs from storage rack on trailer.

5.3.3.5 Visually inspect the cask lift lug bolts for defects and obtain replacement bolts from Energy*Solutions* CMF for any bolts that show cracking or other visual defects. Lubricate bolt threads, if required.

5.3.3.6 Visually inspect lid bolt holes for damage, defects and accumulation of debris. Remove debris, if required. Contact

CMF for any bolt holes that show signs of cracking or visual signs of distress

5.3.3.7 Install lifting lugs on cask and torque bolts to 200 ± 20 ft.-lbs. (lubricated).

5.3.3.8 Connect lifting equipment to the two (2) cask lifting lugs.

Note: Adequate lifting and handling equipment is the responsibility of and will be provided by the user.

Caution: Do not use primary lid or secondary lid lifting lugs to lift cask.

Note: The cables used to lift the cask must have a true angle of not less than 60° with respect to the horizontal.

5.3.3.9 Lift cask out of bottom impact limiter, using suitable lifting equipment.

Note: Empty weight of the cask with lids is approximately 49,640 pounds or as stated on cask nameplate. Total gross design weight of loaded cask is approximately 63,000 pounds.

5.3.3.10 Position the cask on a firm, level supported area.

5.3.3.11 Remove the cask lifting equipment, if required, and proceed with cask use.

5.4 Reinstalling the Cask on Trailer

5.4.1 Locate the trailer.

5.4.1.1 Position the trailer within reach and safe load limits of the crane.

5.4.1.2 Be sure the trailer is level (visual determination).

5.4.2 Prepare cask for reinstallation on trailer.

5.4.2.1 Check all lid bolts on the primary and secondary lids torqued to 500 ± 50 ft.-lbs., using a star pattern. Bolt torque does not have to be checked on bolts with security seals.

5.4.2.2 Reinstall the two (2) cask lifting lugs per steps 5.3.3.5 through 5.3.3.7.

5.4.3 Connect lifting equipment to the two cask lifting lugs.

Note: The cables used to lift the cask must have a true angle of not less than 60° with respect to the horizontal.

Caution: Do not lift cask by lifting lugs on the primary or secondary lids.

Caution: Be sure the lifting equipment is adequate to lift the cask. The empty weight of cask with lids and thermal shield is approximately 49,640 pounds or as stated on nameplate. Total gross design weight of loaded cask is approximately 63,000 pounds.

5.4.4 Prepare mounting surfaces on bottom impact limiter and cask.

Warning: Ensure inner surfaces of impact limiter are below external package limits as specified in Reference 3.2 and/or site release limits. Also, this should include any enclosed surfaces of external cask body.

5.4.4.1 Wipe clean the inside surface of the bottom impact limiter.

5.4.4.2 Verify the interior of the bottom impact limiter is free of debris and has no obvious damage (e.g., rust, holes, gouges, cracks, etc.). Notify Energy*Solutions* CMF if damage is observed.

5.4.4.3 Lift the cask.

5.4.4.4 Inspect and clean the bottom surface of the cask.

5.4.4.5 Verify exterior cask bottom and lower impact limiter surfaces has no obvious damage (e.g., rust, holes, gouges, cracks, etc.). Notify Energy*Solutions* CMF if damage is observed.

5.4.5 Position and slowly lower the cask inside the bottom impact limiter using the alignment mark that was noticed when the cask was removed from the bottom impact limiter.

Caution: Lower cask into bottom impact limiter very slowly to prevent any damage.

5.4.6 Install security seal between lower impact limiter and cask body.

5.4.7 Unbolt and remove cask lifting lugs from the cask and mount the cask lifting lugs on the storage rack on the trailer. Install and securely tighten the bolts.

5.4.8 Replace the cask tie-down cables and tighten.

5.4.9 Replace the secondary lid thermal shield and upper impact limiter. Follow Steps 5.1.2.7 through 5.1.2.7.8.

5.4.10 Return to proper point in handling procedure and proceed with preparing the cask for transport.

5.5. Preparation of Empty Packaging for Transportation

Note: The procedural steps for preparing empty packaging for transportation at the unloading facility are included in Section 5.2. The procedure described in this section is intended to be used when an empty package is prepared for transportation at a location other than an unloading facility.

Note: After completing step 5.5.7, verify that nothing is obstructing the viewing of cask information. Tape, magnets or any other objects may NOT be placed over the cask CoC number, Model/Serial number, name plate information, Type-B, tri-foil etc.

Note. If shipping the cask radioactive empty, UN2908, air drop testing is not required.

5.5.1 Confirm that the cask cavity is empty of radioactive waste contents, to the extent practicable. For foreign material exclusion concerns, cask internals must also be verified clean and clear of all non-radioactive debris.

5.5.2 Survey the cask interior to confirm that the removable contamination does not exceed the limits of 49 CFR 173.428(d). Decontaminate the cask interior as necessary to satisfy the removable contamination does not exceed the limits of 49 CFR 173.428(d).

5.5.3 Replace primary lid.

Note: If the secondary lid is not sealed with a proper Energy*Solutions* security seal, the secondary lid shall be removed for inspection of O-Rings and seating surfaces prior to reinstalling the primary lid on the cask body or may be performed after primary lid is replaced on cask body. Refer to Steps 5.1.4.2.1 through 5.1.4.2.8 for secondary lid removal. After lid removal refer to Steps 5.1.4.4.1 through 5.1.4.4.13 for replacement of secondary lid.

5.5.3.1 Attach the crane hook to the three (3) lifting lugs on the primary lid.

Note: The cables used to lift the primary lid must have a true angle of not less than 45° with respect to the horizontal.

5.5.3.2 The primary lid O-Ring seals shall be visually inspected for serviceability ensuring that they are in the proper position and free of cracks, tears, cuts or discontinuities which may prevent them from sealing properly. The seal seating surface shall be visually inspected to ensure that they are free of damage, debris, gravel, or any foreign matter, which might damage the seals or prevent the seals from properly sealing. If any defects are detected, that may prevent the seals from forming a seal, contact Energy*Solutions* CMF. Inspect and clean the O-Ring seating surfaces. A very thin coat of vacuum grease or petroleum jelly should be applied to the sealing surface of the O-Ring prior to installing and torquing the lid. Inspect the air test annulus and leak test port to assure that they are free of foreign materials (i.e. silicone, vacuum grease, petroleum jelly, etc.).

Warning: Treat all debris removed from the bottom surface of the lid as potentially radiologically contaminated.

5.5.3.3 Clean the bottom surface of the lid and inspect lid bolt holes for damage and accumulation of debris. Remove debris, if required.

5.5.3.4 Visually inspect and clean O-Ring seating surfaces for any damage or material that will prevent O-Rings from forming a seal. If inspection is satisfactory apply a very thin coat of vacuum grease or petroleum jelly. Contact Energy*Solutions* CMF if any damage, nicks, gauges or anything that might interfere with the o-rings sealing properly.

Caution: Care should be taken during handling operations to prevent damage to cask sealing surfaces.

5.5.3.5 Visually inspect the cask lid bolts for defects and obtain replacement for any bolts that show cracking or other visual defects. Lubricate bolt threads, if required and Visually inspect lid bolt holes for damage, defects and accumulation of debris. Remove debris, if required. Contact Energy*Solutions* CMF for any bolt holes that show signs of cracking or visual signs of distress.

5.5.3.6 Lift the primary lid and lower onto the cask and position using alignment marks and alignment pins.

Note: To more easily seat primary lid; after positioning lid within guide pins approximately 1 inch above cask body, start threading each of the 20 bolts by hand. Once all bolts have been started, clear the area and slowly place the lid onto the cask body.

5.5.3.7 Replace and hand tighten the twenty (20) 2-inch primary lid bolts.

Note: Tighten all the bolts hand-tight before starting the torque sequence.

Caution: The use of impact wrenches for the installation of cask lid bolts is not permitted.

5.5.3.8 Torque all bolts to 250 ± 25 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 250 ± 25 ft. lbs., repeating the star pattern.

Note: Pneumatic or hydraulic torque wrenches (non-impacting) may be used to install the bolts.

5.5.3.9 Re-torque all bolts to 500 ± 50 ft.-lbs. (lubricated), using a star pattern. It is recommended that the bolts be torqued a second time to 500 ± 50 ft. lbs., repeating the star pattern.

5.5.3.10 Check torque on all bolts, at least once, using a circular pattern to 500 ± 50 ft.-lbs. If any bolts move, go back to step 5.5.1.9.

Note: Start torque at the same start bolt used in Step 5.5.1.9.

5.5.3.11 Torque the vent port socket head cap screw to 20 ± 2-ft. lbs.

Note: If the vent port socket head cap screw is removed, the vent port seal shall be inspected. If the vent port seal is damaged contact Energy*Solutions* CMF. Prior to installation, the vent port seal shall be installed on the vent port socket head cap screw; and a thin layer of anti-seize should be applied to the vent port socket head cap screw threads.

5. 5.3.12 Seal the primary lid with security seals.

5. 5.3.13 Ensure that all dirt/clay/debris is removed from the cask lids prior to installation of the cask impact limiter.

5.5.4 Replace secondary lid thermal shield and upper impact limiter.

Warning: Ensure inner surfaces of impact limiter are below external package limits as specified in Reference 3.2 and/or site release limits. Also, this should include any enclosed surfaces of external cask body.

5.5.4.1 Using suitable lifting equipment, lift, inspect for damage and install the secondary lid thermal shield. Contact Energy*Solutions* CMF if damage is present.

5.5.4.2 Install the three secondary lid thermal shield retaining pins into the secondary lid lift lugs and insert the ball lock pins into the retaining pins.

5.5.4.3 Attach the crane hook to the lifting lugs on the impact limiter; lift it, and inspect for damage.

5.5.4.4 Position the impact limiter on cask using alignment marks on the cask body and impact limiter and detach the crane hook.

5.5.4.5 Replace the top bolts in the ratchet binders. Insert holding pins.

Note: Visually inspect ratchet binder bolts for any signs of cracking or other visual defects. Replace any defective bolts or pins.

5.5.4.6 Tighten the ratchet binders hand tight and return ratchet handles to storage position leaving flip block in the lock position.

Note: Tools, wrenches, pipes etc. are not permitted to be used on any cask ratchet binder. Using these tools will cause damage to ratchet binders.

5.5.4.7 Place security seals on the impact limiter.

5.5.4.8 Install impact limiter lifting lug covers.

5.5.5 Inspect the cask tie-down cables for tightness. Tighten if necessary.

5.5.6 The Health Physics Technician shall survey all exterior surfaces of the cask for contamination and radiation levels. Decontaminate, as required, to meet the limits set in Site radiation and contamination release procedures and Reference 3.2.

5.5.7 Before the empty cask leaves the shipper's facility, the following shall be confirmed:

5.5.7.1 Cask verified to be empty of radioactive waste. For foreign material exclusion concerns, cask internals must also be verified clean and clear of all non-radioactive debris.

5.5.7.2 Cask internal and external removable contamination does not exceed Site Release Limits, 49 CFR 173.428, 49 CFR 173.443, and 10 CFR 71.87, as applicable (see References 3.2 and 3.5).

5.5.7.3 The cask lid bolts and vent port socket head cap screw are properly torqued.

5.5.7.4 Trailer placarding and cask labeling and marking meet D.O.T. specifications in References 3.1 and 3.2 as applicable.

5.5.7.5 That radiation levels conform to requirements as established in Site radiation and contamination release procedures, 49 CFR 173.441 and, and 10 CFR 71.47, as applicable (see References 3.2 and 3.5).

5.5.7.6 That the cask lids and impact limiters are sealed with security seals.

5.5.7.7 That all lifting lugs are removed or properly covered for transport.

6.0 RECORDS AND REPORTS

The following reports should accompany all loaded shipments and be maintained in accordance with Reference 3.4 or other facility applicable records requirements.

6.1 Shipping papers per 49 CFR Part 172 (see Reference 3.1) - prepared and certified by the shipper

6.2 Vehicle Radiation Survey -- prepared and certified by the shipper.

6.3 User Check-Off Sheet or equivalent form -- prepared and signed by the shipper (see Attachment 7.1).

6.4 Prior Notification Forms (if required).

6.5 State Permit Forms (if required).

6.6 Statement that air leak test of cask has been completed.

7.0 ATTACHMENTS

7.1 User Check-Off Sheet

Attachment 7.1
USER CHECK-OFF SHEET

Date _____ Shipment Number _____ Waste Identification _____
Operator(s) _____ HP Technician(s) _____
_____ Cask ID/Serial Number _____
Shipper _____ Driver _____
Time of arrival on site _____ Time of departure from site _____

PLEASE INITIAL WHEN COMPLETED	OPERATOR (O)	SHIPPER (S)
1) Two independent physical verifications of secondary container's closure system, if required.		
2) Check interior of cask, bolts and bolt holes for foreign material / water		
3) Primary lid o-rings and seating surface inspected, if lid removed		
4) Secondary lid o-rings and seating surface inspected if lid removed		
5) Primary lid bolts torqued Torque wrench data: Serial # _____ Calibration Date_____ Calibration Due Date_____		
6) Secondary lid bolts torqued Torque wrench data: Serial # _____ Calibration Date_____ Calibration Due Date_____		
7) Secondary Lid thermal shield replaced		
8) Impact limiter ratchet binders replaced, hand tighten and left in the lock position		
9) For a loaded cask, both Primary and Secondary Lids and vent port have been air leak tested.		
10) All 3 test port set screw plugs replaced/hand tightened and vent port socket head cap screw with o-ring replaced/torqued Torque wrench data: Serial # _____ Calibration Date _____ Calibration Due Date _____		
11) If cask removed from lower impact limiter; follow steps 5.4.4.2 through 5.4.4.5. and forward bottom of cask/lower impact survey to Energy*Solutions* CMF.		
12) Upper impact limiter to cask body security seal installed. Seal #_____		
13) Other Security Seals on Secondary and Primary lid, Cask Body to Lower Impact, Upper Impact Man Way and Trailer Tool Box Installed or Verified in place.		
14) Impact limiter lifting lug covers replaced		
15) Cask tie-downs hand tighten, inspected and taunted		
16) Cask labels and marking adhered correctly and legible.		

PLEASE COMPLETE AND INITIAL	SHIPPER/ SUPERVISOR (S)	HEALTH PHYSICS TECH (HP)	
17) Cask payload (including shoring)	Max. 13,360 lbs.	Actual	Initials
18) Decay heat (if applicable)	Max. 200 W	Actual	Initials
19) Gamma - _____ at 2 meters from trailer		(HP)	(S)
20) Gamma - _____ at cask surface		(HP)	(S)
21) Gamma - _____ in tractor cab		(HP)	(Sa)
22) Smearable beta-gamma (d/m/100 cm^2) _____		(HP)	(S)
23) Smearable alpha (d/m/100 cm^2) _____		(HP)	(S)

I hereby certify that the above statements are correct and the cask has been loaded and tested in accordance with approved procedures.

Operators _____ _____
_____ _____
Health Physics Tech(s) _____ _____
_____ _____
Supervisors/Shipper(s) _____ _____

Air Pressure Drop Test For Model 8-120B Cask Certificate of Compliance 9168

Revision 20

Authored By: Christopher S. Libert — 12-16-2013
Christopher S. Libert, Cask Operations Engineer — Date

Reviewed By: Digitally signed by Steven Sisley Date: 2013.12.16 11:02:35 -08'00'
Steven Sisley, Cask Licensing Manager — Date

Approved By: Phillip H Thomas — 12/23/13
Phillip H. Thomas, Director – Cask Logistics — Date

- [X] Non-Proprietary
- [ ] Proprietary
- [ ] Restricted Information
- [ ] Safeguards Information
- [ ] Sensitive Security Information

- [ ] New
- [ ] Title Change
- [X] Revision
- [ ] Rewrite
- [ ] Cancellation

Effective Date: January 1, 2014

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1. SCOPE

1.1 Purpose

This procedure delineates the requirements for performing an air pressure drop test on the Model 8-120B shipping casks. This test will prove the integrity of the O-rings for the primary and secondary lids and the vent port on the Model 8-120B cask.

1.2 Applicability

This procedure establishes the method for pre-shipment verification air leak testing of the Model 8-120B shipping cask. Nuclear Regulatory Commission Certificate of Compliance Number is 9168 (see Reference 2.2.).

2. REFERENCES

2.1 TR-OP-035, Handling Procedure for Transport Cask CNS 8-120B, Certificate of Compliance Number 9168 (latest revision required)

2.2 Certificate of Compliance Number 9168 (Docket Number 71-9168) issued by the Nuclear Regulatory Commission (latest revision required)

2.3 ES-QA-PR-005, Records

2.4 Drawing DWG-CSK-12GCL1-ME-001, Air Test Manifold or equivalent system

2.5 ES-AD-PR-013, Control of Nonconforming Items

2.6 Drawing, C-110-E-0007, *8-120B Shipping Cask*

3. DEFINITIONS

3.1 *Set Screw Plug* — 1-1/2" set screw used to plug all 3 test ports; Reference 2.6, Item 34.

3.2 *Socket Head Cap Screw* — 1/2" socket head cap screw used to plug vent port; Reference 2.6, Item 27.

3.3 *Lid Bolts* — 2" hex head bolt used to fasten primary and secondary lids to cask body; Reference 2.6, Item 39.

3.4 *Vent Port Seal* — o-ring used to seal vent port; Reference 2.6, Item 26.

3.5 *Lid O-Ring* — Inner and outer o-rings used to seal primary and secondary lids; Reference 2.6, Items 22 thru 25.

4. REQUIREMENTS

4.1 Prerequisites

Note: Examination of o-rings is only necessary if the lid or vent port socket head cap screw is removed.

4.1.1 The cask shall be examined visually for integrity, condition of o-rings, and sealing surfaces. Cask sealing surfaces must be free of any defects that would prevent forming a seal.

4.1.2 Cask sealing surfaces shall be clean and free of contaminants, which could affect the leak test.

4.1.3 Moisture in the test air may affect the test results. Therefore, the air should be as dry as possible.

Note: Nitrogen may be used in place of plant air.

4.1.4 A troubleshooting guide is listed on Appendix B of this procedure. Refer to Appendix B prior to assembly of the cask and/or prior to performing the air leak test.

4.2 Tools, Materials, and Equipment

4.2.1 Air Induction Test Manifold (see References 2.4) or a similar system.

4.2.2 Calibrated gauge capable of indicating 30 psig ± 1% of full scale with a maximum graduation of 0.1 psig. The accuracy of the gauge shall be verified at least annually. RECORD GAUGE CALIBRATION INFORMATION ON APPENDIX A.

4.2.3 Sockets and wrenches

4.2.3.1 3/8” allen wrench by 3/8” drive socket

4.2.3.2 3/4” allen wrench

4.2.4 Calibrated 0-50 ft.-lb. torque wrench, or equivalent, with appropriate adapter to fit socket head cap screw listed in Step 5.3.4. RECORD TORQUE WRENCH CALIBRATION INFORMATION ON APPENDIX A.

4.2.5 O-Ring lubricant vacuum grease or petroleum jelly

4.2.6 Acceptable bolt/plug lubricant (Moly-Z, Neolube, or anti-seize).

4.3 **Precautions/Limits**

4.3.1 **THE CASK WILL NEED TO BE UNLOADED IF LOADED AND SHIPPED BACK TO CMF EMPTY IF PRIMARY LID, SECONDAY LID OR VENT PORT O-RINGS NEED REPLACED**.

4.3.2 **DO NOT EXCEED A PRESSURE OF 20 PSIG.**

4.3.3 DO NOT over-tighten the manifold when connecting it to the test port. If it is over-tightened, the o-ring or adapter may be damaged. Apply pressure very slowly to prevent damage to o-ring.

4.4 **Acceptance Criteria**

The test pressure of 18 psig (+1, –0) must be held for fifteen (15) minutes (+5, -0) for the primary and secondary lids and the vent port. A drop in pressure greater than the minimum detectable amount (i.e., one-half of the maximum graduation of the pressure gauge, or 0.05 psig) shall be cause for test failure.

Note: Energy*Solutions* requires leak testing of the cask lids and vent port prior to every 8-120B cask shipment, even if the lid bolts or vent port socket head cap screw have not been loosened during loading operations. This requirement is necessary to assure that the 8-120B cask containment system is properly assembled prior to every shipment since it should not be assumed that the containment system is properly assembled prior to loading operations.

Note: The primary lid, secondary lid and vent port seal may be performed in non-sequential order.

4.5 **Responsibilities**

4.5.1 A person familiar with the requirements of this procedure shall perform the pressure drop test.

4.5.2 A person familiar with the requirements of this procedure shall witness the pressure drop test to verify that the requirements of this procedure are satisfied during testing.

Note: The person witnessing the pressure drop test shall not be the same person performing the test.

4.5.3 Operations and/or maintenance personnel are responsible for preparing the container for testing and providing support during the pressure drop test.

5. DETAILED PROCEDURE

Note: This procedure must be used with the latest revision of the 8-120B cask handling procedure TR-OP-035.

5.1 Pressure Drop Test For Secondary Lid O-Ring Seal

Note: Review the troubleshooting guide listed in Appendix B prior to performing the air pressure drop leak test. Following the instructions in Appendix B should help obtain a successful air leak test of the cask.

5.1.1 Ensure cask is assembled in accordance with Reference 2.1 and applicable drawings listed in Reference 2.2. Verify cask lid bolts and vent port socket head cap screw are properly torqued to values listed in the cask handling procedure.

5.1.2 Using a 3/4-inch allen wrench, remove set screw plug from the secondary lid test port. Retain for reinstallation.

5.1.3 Remove any debris/foreign materials from the air test port.

5.1.4 Ensure that the o-ring on the adapter/test manifold is in good condition and lubricated. Replace if necessary. Attach manifold to secondary lid test port by placing the manifolds trunk down into test port. Next hand tighten the threaded bushing until it is snug. If needed, a wrench may be used to tighten the bushing but only ¼ turn or less until snug.

Note: Over tightening can cause damage to the test manifolds o-ring and the test port threads. Use caution and proceed slowly to ensure test manifold bushing is not over tighten.

5.1.5 Ensure the Air Regulator Inlet Valve, located on the inlet side of the Air Regulator and the Leak Test Supply Valve, located on the inlet side of the Test Pressure Gauge are closed. Connect the adaptor/test manifold to the secondary lid test port.

Note: Use extreme caution when connecting adapter/test manifold to test port to prevent damage to test port threads.

5.1.6 Set the Air Regulator located on the manifold to 0 psig or OFF and connect the air supply to the manifold.

Caution: A very small volume is being pressurized. Use extreme care and do not exceed 20 psig.

5.1.7 Slowly open the Air Regulator Inlet Valve.

5.1.8 Slowly open the Leak Test Supply Valve. After the Leak Test Supply Valve is open, slowly adjust the Air Regulator to obtain 18 psig (+1, -0 psig) on the Test Pressure Gauge. Use extreme care so the Test Pressure Gauge is not over pressurized.

Note: Due to temperature changes it may be necessary to adjust the pressure back to 18 psig. The pressure should not drop when the regulating shut-off valve is closed. It may take up to 30 minutes for the temperature to equalize.

5.1.9 Once 18 psig (+1, -0 psig) is obtained on the Test Pressure Gauge, close the Leak Test Supply Valve.

5.1.10 Set the Air Regulator to 0 psig or OFF and close the Air Regulator Inlet Valve.

5.1.11 Disconnect the air supply from the manifold. Record the time on the "Air Leak Test Inspection Form". (Appendix A)

5.1.12 After a period of fifteen (15) minutes (+5, -0), pressurized at 18 psig (+1, -0) psig and no drop in pressure greater than the minimum detectable amount, record time on Appendix A. Connect off-gas header (if required by plant procedure) to the control side of the test manifold. Slowly, open valves on the test manifold and bleed air from cask.

Note: Air bled from cask is potentially contaminated. Take appropriate health physics precautions.

5.1.13 If pressure drop test fails, the secondary lid may be pulled and inspected. The o-rings and seating surface condition, lid tightness, etc. shall be checked, corrected, and the test repeated. Refer to Appendix B for air leak test troubleshooting.

5.1.14 In the event of subsequent air pressure drop test failures, refer to Appendix B for troubleshooting and contact Energy*Solutions* CMF for assistance, if needed.

5.1.15 After successfully completing the required air pressure drop test of the secondary lid o-rings, remove the air test manifold and all associated parts, treating all parts as potentially contaminated, and inspect the set screw plug to ensure that there are no defects (i.e. cracks, deformed or stripped threads, etc.). If the set screw plug is defective, obtain a replacement from Energy*Solutions*.

5.1.16 Clean the test port set screw plug of all debris, thread tape, ect. and reinstall in the primary lid. Hand tighten until the set screw plug is snug.

5.2 **Pressure Drop Test For Primary Lid O-Ring Seal**

Note: Review the troubleshooting guide listed in Appendix B prior to performing the air pressure drop leak test. Following the instructions in Appendix B should help obtain a successful air leak test of the cask.

5.2.1 Ensure cask is assembled in accordance with Reference 2.1 and applicable drawings listed in Reference 2.2. Verify cask lid bolts and vent port socket head cap screw are properly torqued to values listed in the cask handling procedure.

5.2.2 Using a 3/4-inch allen wrench, remove the set screw plug from the primary lid test port. Retain for reinstallation. Remove any debris/foreign materials from the air test port.

5.2.3 Ensure that the o-ring/gasket on the adapter/test manifold is in good condition and lubricated. Replace if necessary. Attach manifold to primary lid test port by placing the manifolds trunk down into test pot. Next hand tighten the threaded bushing until it is snug. If needed, a wrench may be used to tighten the bushing but only ¼ turn or less until snug.

Note: Over tightening can cause damage to the test manifolds o-ring and the test port threads. Use caution and proceed slowly to ensure test manifold bushing is not over tighten.

5.2.4 Ensure the Air Regulator Inlet Valve, located on the inlet side of the Air Regulator and the Leak Test Supply Valve, located on the inlet side of the Test Pressure Gauge are both closed. Connect the adaptor/test manifold to the primary lid test port.

Note: Use extreme caution when connecting adapter/test manifold to test port to prevent damage to test port threads.

5.2.5 Set the Air Regulator located on the manifold to 0 psig or OFF and connect the air supply to the manifold.

Caution: A very small volume is being pressurized. Use extreme care and do not exceed 20 psig.

5.2.6 Slowly open the Air Regulator Inlet Valve.

5.2.7 Slowly open the Leak Test Supply Valve. After the Leak Test Supply Valve is open, slowly adjust the Air Regulator to obtain 18 psig (+1, -0 psig) on the Test Pressure Gauge. Use extreme care so the Test Pressure Gauge is not over pressurized.

Note: Due to temperature changes it may be necessary to adjust the pressure back to 18 psig. The pressure should not drop when the regulating shut-off valve is closed. It may take up to 30 minutes for the temperature to equalize.

5.2.8 Once 18 psig (+1, -0 psig) is obtained on the Test Pressure Gauge, close the Leak Test Supply Valve.

5.2.9 Set the Air Regulator to 0 psig or OFF and close the Air Regulator Inlet Valve.

5.2.10 Disconnect the air supply from the manifold. Record the time on the "Air Leak Test Inspection Form". (Appendix A)

5.2.11 After a period of fifteen (15) minutes (+5, -0), pressurized at 18 psig (+1, -0) psig and no drop in pressure greater than the minimum detectable amount, record time on Appendix A. Connect off-gas header (if required by plant procedure) to the control side of the test manifold. Slowly, open valves on the test manifold and bleed air from cask.

Note: Air bled from cask is potentially contaminated. Take appropriate health physics precautions.

5.2.12 If pressure drop test fails, the o-rings and seating surface condition, lid tightness, etc. shall be checked, corrected, and the test repeated. Refer to Appendix B for air leak test troubleshooting.

5.2.13 In the event of subsequent air pressure drop test failures, refer to Appendix B for troubleshooting and contact Energy*Solutions* CMF for assistance, if needed.

5.2.14 After successfully completing the required air pressure drop test of the primary lid o-rings, remove the air test manifold and all associated parts, treating all parts as potentially contaminated, and inspect the set screw plug to ensure that there are no defects (i.e. cracks, deformed or stripped threads, etc.). If the set screw plug is defective, obtain a replacement from Energy*Solutions*.

5.2.15 Clean the set screw plug of all debris, thread tape, ect. and reinstall in the primary lid. Hand tighten until the set screw plug is snug.

5.3 **Pressure Drop Test For Vent Port**

Note: Review the troubleshooting guide listed in Appendix B prior to performing the air pressure drop leak test. Following the instructions in Appendix B should help obtain a successful air leak test of the cask.

Note: If the vent port seal/o-ring is damaged contact EnergySolutions cask maintenance group. The cask shall receive an annual leak test anytime the seal/o-ring needs replaced.

5.3.1 Ensure cask is assembled in accordance with Reference 2.1 and applicable drawings listed in Reference 2.2. Verify cask lid bolts and vent port socket head cap screw are properly torqued to values listed in the cask handling procedure.

5.3.2 Using a 3/4-inch allen wrench, remove the set screw plug from the vent port. Retain for reinstallation.

5.3.3 Remove any debris/foreign materials from the vent port.

5.3.4 Using a 3/8" allen wrench by 3/8" drive socket, verify the torque on the vent port socket head cap screw to be 20 ft-lbs.

5.3.5 Ensure that the o-ring on the adapter/test manifold is in good condition and lubricated. Replace if necessary. Attach manifold to vent port by placing the manifolds trunk down into test port. Next hand tighten the threaded bushing until it is snug. If needed, a wrench may be used to tighten the bushing but only ¼ turn or less until snug.

Note: Over tightening can cause damage to the test manifolds o-ring and the test port threads. Use caution and proceed slowly to ensure test manifold bushing is not over tighten.

5.3.6 Ensure the Air Regulator Inlet Valve, located on the inlet side of the Air Regulator and the Leak Test Supply Valve, located on the inlet side of the Test Pressure Gauge are closed. Connect the adaptor/test manifold to the vent test port.

Note: Use extreme caution when connecting adapter/test manifold to test port to prevent damage to test port threads.

5.3.7 Set the Air Regulator located on the manifold to 0 psig or OFF and connect the air supply to the manifold.

Caution: A very small volume is being pressurized. Use extreme care and do not exceed 20 psig.

5.3.8 Slowly open the Air Regulator Inlet Valve.

5.3.9 Slowly open the Leak Test Supply Valve. After the Leak Test Supply Valve is open, slowly adjust the Air Regulator to obtain 18 psig (+1, -0 psig) on the Test Pressure Gauge. Use extreme care so the Test Pressure Gauge is not over pressurized.

Note: Due to temperature changes it may be necessary to adjust the pressure back to 18 psig. The pressure should not drop when the regulating shut-off valve is closed. It may take up to 30 minutes for the temperature to equalize.

5.3.10 Once 18 psig (+1, -0 psig) is obtained on the Test Pressure Gauge, close the Leak Test Supply Valve.

5.3.11 Set the Air Regulator to 0 psig or OFF and close the Air Regulator Inlet Valve.

5.3.12 Disconnect the air supply from the manifold. Record the time on the "Air Leak Test Inspection Form". (Appendix A)

5.3.13 After a period of fifteen (15) minutes (+5, -0), pressurized at 18 psig (+1, -0) psig and no drop in pressure greater than the minimum detectable amount, record time on Appendix A. Connect off-gas header (if required by plant procedure) to the control side of the test manifold. Slowly, open valves on the test manifold and bleed air from cask.

Note: Air bled from cask is potentially contaminated. Take appropriate health physics precautions.

5.3.14 If the air pressure drop test fails, perform the following steps and refer to Appendix B for troubleshooting:

5.3.14.1 Remove the vent port socket head cap screw using a 3/8" allen wrench.

5.3.14.2 Visually inspect the socket head cap screw and seal/o-ring to ensure that they are in good condition, free of defects, and that the vent port seal/o-ring is properly installed on the socket head cap screw. Obtain a replacement socket head cap screw from Energy*Solutions* CMF if defective.

Note: If the vent port seal/o-ring is damaged contact EnergySolutions CMF. The cask shall receive an annual leak test anytime the vent port seal is replaced.

5.3.14.3 Visually inspect the vent port sealing surface to ensure that it is satisfactory and clean sealing surface if needed.

5.3.14.4 Lubricate the threads of the socket head cap screw with anti-seize. Lubricate the vent port seal/o-ring with vacuum grease or petroleum jelly. Carefully reinstall the socket head cap screw and seal/o-ring into the vent port and torque to

20 ft-lbs in accordance with the cask handling procedure (Reference 2.1).

5.3.15 In the event of subsequent air pressure drop test failures, refer to Appendix B for troubleshooting and contact Energy*Solutions* CMF for assistance, if needed.

5.3.16 After successfully completing the required air pressure drop test of the vent port seal/o-ring, remove the air test manifold and all associated parts, treating all parts as potentially contaminated, and inspect the set screw plug to ensure that there are no defects (i.e. cracks, deformed or stripped threads, etc.). If the set screw plug is defective, obtain a replacement from Energy*Solutions*.

5.3.17 Clean the set screw plug of all debris, thread tape, ect. and reinstall in the primary lid. Hand tighten until the plug is snug.

5.4 **Storage of the Manifold**

After completion of the leak test(s), remove the air test manifold and all associated parts, treating all parts as potentially contaminated, and replace in storage box located on trailer. Test gauge must be disconnected from the test manifold and stored back in its' protected case within the cask trailer tool box.

6. RECORDS

6.1 Each leak test performed shall be documented on an Air Leak Test Inspection Form (see Appendix A) or equivalent form. If this procedure is performed at a Energy*Solutions* facility any records (including Appendix A) generated shall be maintained in accordance with Reference 2.3.

6.2 When a leak test is performed at a customer's facility, a copy of Appendix A or equivalent form shall be maintained by the shipper in accordance with 10CFR71.91. Furthermore, a copy of Appendix A or equivalent form should be forwarded to Energy*Solutions*; whereby the form shall be stored in accordance with Reference 2.3.

APPENDIX A
8-120B AIR LEAK TEST INSPECTION FORM

DATE OF TEST _____ CASK SERIAL NUMBER/ID NUMBER_____

SERIAL NUMBER:	PRESSURE GAUGE_____	TORQUE WRENCH_____
CALIBRATION DATE:	PRESSURE GAUGE_____	TORQUE WRENCH_____
CALIBRATION DUE DATE:	PRESSURE GAUGE_____	TORQUE WRENCH_____

PRIMARY LID

Initial Pressure	_____	Psig	Test Start Time	_____
Final Pressure	_____	Psig	Test End Time	_____
Pressure Drop	_____	Psig	Elapsed Time	_____
			(15 +5/-0 minutes)	

Pressure Drop ≤ Min. Detectable Amount (Section 4.4) ---------- (Circle One) Passed Failed

SECONDARY LID

Initial Pressure	_____	Psig	Test Start Time	_____
Final Pressure	_____	Psig	Test End Time	_____
Pressure Drop	_____	Psig	Elapsed Time	_____
			(15 +5/-0 minutes)	

Pressure Drop ≤ Min. Detectable Amount (Section 4.4) ---------- (Circle One) Passed Failed

VENT PORT

Initial Pressure	_____	Psig	Test Start Time	_____
Final Pressure	_____	Psig	Test End Time	_____
Pressure Drop	_____	Psig	Elapsed Time	_____
			(15 +5/-0 minutes)	

Pressure Drop ≤ Min. Detectable Amount (Section 4.4) ---------- (Circle One) Passed Failed

Note: If leakage is noted, indicate actions taken in remarks section. Retest is required upon test failure.

REMARKS _____

_____

TEST CONDUCTED BY _____

TEST WITNESSED BY _____

APPENDIX B – PAGE 1
TROUBLESHOOTING GUIDE FOR LEAK TESTING THE 8-120B CASK

Listed below are some suggestions for performing an air leak test on the 8-120B cask. Following these suggestions should help achieve a successful air leak test.

1. Use extreme care when removing and/or replacing the cask lids (primary or secondary) to prevent damage to the o-rings.
2. Ensure that the o-ring sealing surfaces are clean. Acetone (or an equivalent cleaning solution) works very well to clean the o-ring sealing surfaces.
3. Inspect the o-rings and ensure they are in good condition and properly installed.
4. Gently clean the o-rings and clear any unwanted debris before re-lubricating.
5. The o-rings should be lubricated with a small amount of o-ring lubricant or petroleum jelly. Parker O-ring Lube works very well. A thin coat of o-ring lubricant or petroleum jelly may be applied to the o-ring sealing surface.
6. Ensure the air test port and the connection line to the air test annulus are free all foreign materials. A small wire should be pushed through the test port line. This will ensure that the line does not have any internal blockage that could restrict airflow to the annulus.
7. Ensure the air test port and the air test port o-ring sealing surface is clean and free of any foreign materials. Foreign materials and debris may prevent the o-ring on the leak test adapter/test manifold from properly sealing.
8. The cask lids must be torqued in accordance with the cask handling procedure. This torquing sequence ensures the lids are evenly seated and tightened.
9. Inspect the o-ring that is on the air test port adapter/test manifold to ensure it is in good condition and will properly seal. The o-ring should be lubricated with a small amount of o-ring lubricant or petroleum jelly. Parker O-ring Lube works very well.
10. Install the air test port adapter/test manifold into the lid air test port and tighten snuggly. Do not over-tighten. If the adapter/test manifold is tightened too much, the o-ring will be damaged and not properly sealed.
11. Ensure the valves on the test manifold are closed and the air regulator is set on zero prior to connecting the air hose to the manifold. This is to ensure the pressure gauge is not over pressurized. Ensure that the quick disconnects are properly connected.
12. The air used for the test should be dry and free of moisture.

APPENDIX B – PAGE 2
TROUBLESHOOTING GUIDE FOR LEAK TESTING THE 8-120B CASK

13. Allow pressure to equalize by applying the pressure for 20 to 30 minutes (i.e., this soak time allows the temperature and pressure to equalize). The manifold isolation valve should remain closed during the soak period. After the soak time, adjust the pressure to 18 +1-0 psig. Lightly tap the gauge face after the required test pressure has been obtained to alleviate any hysteresis effects on the gauge reading. Start the leak test period of 15 minutes.

14. If pressure dropped more than 0.1 psig after the leak test time period has started, check the following:

    a. Soap bubble test the connection between the air test port adapter/manifold and the cask lid.

    b. Soap bubble test all the connections on the air isolation part of the test manifold and the quick disconnect.

    c. Check the cask lid bolts to ensure they are torqued to 500 +50-0 ft.lbs.

Approvals Page

Conformance of CNS 8-120B Cask with Specifications for Industrial Packaging Type 1 and Type 2

Prepared by:	Signature on File	10/8/02
	Shayne Merritt, Project Engineer	Date
Independent Reviewer:	Signature on File	10/8/02
	Patrick L. Paquin, General Manager	Date

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1.0 Introduction

This report evaluates the CNS 8-120B cask's conformance with 49CFR173.411 "Industrial Packaging" (Reference 5.1). This report fulfills the requirement of 49CFR173.411 for IP-2 packages, which specifies that:

> *Except for IP-1 packages, each offeror of an industrial package must maintain on file for at least one year after the latest shipment, and shall provide to the Associate Administrator for Hazardous Materials Safety on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification.*

2.0 Discussion

The CNS 8-120B is licensed by the US NRC under Certificate of Compliance USA\9168\B. The CNS 8-120B was certified as a Type B package by demonstrating compliance with NRC Type B requirements specified in 10CFR Part 71. Therefore, the CNS 8-120B should readily meet the requirements for an IP-2 package. Nevertheless, this report examines each regulatory requirement individually to assess the package's conformance to IP-2 specifications. However, where appropriate, references are made to the Safety Analysis Report for the CNS 8-120B (Reference 5.2) that was prepared to support certification by the NRC. Since the requirements for an IP-2 packaging are more stringent than for an IP-1, this report will serve as a basis for use of the cask as an IP-1 packaging as well.

This Engineering Report evaluates the shipment of solid or liquid radioactive material in this cask when used as an IP-2 or an IP-1 packaging. While the SAR does not specify liquid form as a permitted content, this omission only applies when using the cask as a Type B packaging. The analysis that follows considers the contents to be in liquid or solid state.

The shipper is also responsible for ensuring that the contents do not exceed any of the limits placed on the contents by the analyses in this report.

The applicable requirements for IP-2 packagings is given in 49CFR173.411(b)(2), which is as follows:

> *Each IP-2 must meet the general design requirements prescribed in §173.410 and when subjected to the tests specified in §173.465 (c) and (d) or evaluated against these tests by any of the methods authorized by §173.461(a), must prevent: (i) Loss or dispersal of the radioactive contents; and (ii) A significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.*

Therefore, in addition to §178.350, the requirements for IP-2 packagings are given in the following sections of §173:

Subpart A: General
Subpart B: Preparation of Hazardous Materials for Transportation
173.403: Definitions
173.410: General Design Requirements
173.465: Type A Packaging Tests

The CNS 8-120B is assessed in Section 3.0 below of this report against each of the above requirements. (The requirements of §173.403 are not evaluated, since it contains only definitions rather than specifications.) The methods for demonstrating compliance with the test requirements of §173.465 are given in §173.461. These are; (1) performance of tests, (2) reference to a previous, satisfactory, demonstration of compliance, (3) performance of tests with models, or (4) calculations or reasoned evaluation. The primary method used in this report is method number 4, or reference to the cask SAR which also primarily uses method 4.

This report evaluates the CNS 8-120B for meeting applicable IP-2 requirements. By meeting IP-2 requirements, the package will also meet the requirements for an IP-1 package.

3.0 Results

49CFR173, Subpart A: General

Subpart A does not include any prescriptive specifications for the package.

Part 173 Subpart B: Preparation of Hazardous Materials for Transportation

173.21 Forbidden materials and packages.

This section contains specifications that are either not applicable to the 8-120B, or that must be met by the shipper relative to contents of a shipment.

173.22 Shipper's responsibility.

This section contains specifications that must be met by the shipper.

173.22a Use of packagings authorized under exemptions.

This section is not applicable to the CNS 8-120B.

173.23 Previously authorized packaging.

This section is not applicable to the CNS 8-120B.

173.24 General requirements for packagings and packages.

(a) Applicability. Except as otherwise provided in this subchapter, the provisions of this section apply to-

(1) Bulk and non-bulk packagings;

(2) New packagings and packagings which are reused; and

(3) Specification and non-specification packagings.

The CNS 8-120B is classified as a bulk packaging. Therefore this section is applicable.

(b) Each package used for the shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation-

(1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;

(2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;

(3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.

This specification is demonstrated to be met in Section 2.6.10 in the CNS 8-120B SAR.

(c) Authorized packagings. A packaging is authorized for a hazardous material only if-

(1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the §172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the §172.101 Table and, for specification packagings (but not including UN standard packagings manufactured outside the United States), the specification requirements in parts 178 and 179 of this subchapter; or

(2) The packaging is permitted under, and conforms to, provisions contained in §§171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27, or 176.11 of this subchapter.

Column 8 of the §172.101 Table specifies the applicable packaging specifications and exceptions for a hazardous materials being addressed (for example, Radioactive Material, LSA, n.o.s.).

(d) Specification packagings and UN standard packagings manufactured outside the U.S.

(1) Specification packagings. A specification packaging, including a UN standard packaging manufactured in the United States, must conform in all details to the applicable specification or standard in part 178 or part 179 of this subchapter.

(2) UN standard packagings manufactured outside the United States. A UN standard packaging manufactured outside the United States, in accordance with national or international regulations based on the UN Recommendations on the

Transport of Dangerous Goods, may be imported and used and is considered to be an authorized packaging under the provisions of paragraph (c)(1) of this section, subject to the following conditions and limitations:

(i) The packaging fully conforms to applicable provisions in the UN Recommendations on the Transport of Dangerous Goods and the requirements of this subpart, including reuse provisions;

(ii) The packaging is capable of passing the prescribed tests in part 178 of this subchapter applicable to that standard; and

(iii) The competent authority of the country of manufacture provides reciprocal treatment for UN standard packagings manufactured in the U.S.

Not applicable.

(e) Compatibility

(1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly applies to corrosivity, permeability, softening, premature aging and embrittlement.

(2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.

(3) Plastic packagings and receptacles.

(i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.

(ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate of Permeation in Plastic Packagings and Receptacles"). The procedure specified in appendix B of this part must be performed on each plastic packaging or receptacle used for Packing Group I materials. The maximum rate of permeation of hazardous lading through or into the plastic packaging or receptacles may not exceed 0.5 percent for materials meeting the definition of a Division 6.1 material according to §173.132 and 2.0 percent for other hazardous materials, when subjected to a temperature no lower than-

(A) 18 °C (64 °F) for 180 days in accordance with Test Method 1 in appendix B of this part;

(B) 50 °C (122 °F) for 28 days in accordance with Test Method 2 in appendix B of this part; or

(C) 60 °C (140 °F) for 14 days in accordance with Test Method 3 in appendix B of this part.

(iii) Alternative procedures or rates of permeation are permitted if they yield a level of safety equivalent to or greater than that provided by paragraph (e)(3)(ii) of this section and are specifically approved by the Associate Administrator for Hazardous Materials Safety.

(4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or nonhazardous materials if such materials are capable of reacting dangerously with each other and causing-
(i) Combustion or dangerous evolution of heat;
(ii) Evolution of flammable, poisonous, or asphyxiant gases; or
(iii) Formation of unstable or corrosive materials.
(5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

This section contains specifications that must be met by the shipper.

(f) Closures
(1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation-
(i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and
(ii) The closure is secure and leakproof.
(2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

As discussed in the Chapter 4 of the SAR under the requirements of 10CFR 71 §71.43 and 71.51, the package meets the requirements of this section.

(g) Venting. Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when-
(1) Transportation by aircraft is not involved;
(2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;
(3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and
(4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the §172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

Not applicable.

(h) Outage and filling limits
(1) General. When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packagings are specified in §§173.24a(d) and 173.24b(a), respectively.

(2) Compressed gases and cryogenic liquids. Filling limits for compressed gases and cryogenic liquids are specified in §§173.301 through 173.306 for cylinders and §§173.314 through 173.319 for bulk packagings.

(i) Air transportation. Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in §173.27, except as provided in §171.11 of this subchapter.

This section contains specifications that must be met by the shipper.

173.24a Additional general requirements for non-bulk packagings and packages.

Not applicable; the CNS 8-120B is classified as a bulk packaging.

173.24b Additional general requirements for bulk packagings.

This section contains specifications that must be met by the shipper.

173.25 Authorized packages and overpacks.

Not applicable; this section addresses specifications for overpacks and the package is not classified as an overpack.

173.26 Quantity limitations.

When quantity limitations do not appear in the packaging requirements of this subchapter, the permitted gross weight or capacity authorized for a packaging is as shown in the packaging specification or standard in part 178 or 179, as applicable, of this subchapter.

The permitted capacity and gross weight is given in Chapter 1 of the SAR and marked on the package nameplate.

173.27 General requirements for transportation by aircraft.

Not applicable; the CNS 8-120B is not designed to be transported by aircraft.

173.28 Reuse, reconditioning and remanufacture of packagings.

(a) General. Packagings and receptacles used more than once must be in such condition, including closure devices and cushioning materials, that they conform in all respects to the prescribed requirements of this subchapter. Before reuse, each packaging must be inspected and may not be reused unless free from incompatible residue, rupture, or other damage which reduces its structural integrity.

The package is inspected, as specified in Chapter 7 of the SAR, before each reuse.

(b) Reuse of non-bulk packaging. A non-bulk packaging used more than once must conform to the following provisions and limitations:

Not applicable; the package is classified as a bulk package.

173.29 Empty packagings.

This section contains specifications that must be met by the shipper.

173.30 Loading and unloading of transport vehicles.

A person who loads or unloads hazardous materials into or from a transport vehicle or vessel shall comply with the applicable loading and unloading requirements of parts 174, 175, 176, and 177 of this subchapter.

This section contains specifications that must be met by the shipper.

173.31 Use of tank cars.

Not applicable.

173.32 Requirements for the use of portable tanks.

Not applicable.

173.33 Hazardous materials in cargo tank motor vehicles.

Not applicable.

173.34 Qualification, maintenance and use of cylinders.

Not applicable.

173.35 Hazardous materials in intermediate bulk containers.

Not applicable.

173.40 General packaging requirements for poisonous materials required to be packaged in cylinders.

Not applicable.

173.410: General design requirements.

In addition to the requirements of subparts A and B of this part, each package used for the shipment of Class 7 (radioactive) materials must be designed so that-
(a) The package can be easily handled and properly secured in or on a conveyance during transport.

The cask is equipped with lifting attachments for handling. Cask loading and unloading procedures are specified in Chapter 7 of the SAR. During transport, the cask is tied down to the trailer deck. The tiedown system is evaluated structurally in Section 2.4.4 of the Safety Analysis Report (SAR).

(b) Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

Section 2.4.3 of the SAR demonstrates that the structural requirements of the lifting attachments are met. Failure of the lifting attachment will not impair the ability of the package to meet other requirements of this subpart. There are no other structural parts of the package that could be used to lift it.

(c) The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.

The external surfaces of the package are free of protruding features, except those necessary for the package to perform its function. The external surfaces are hard and smooth and therefore easily decontaminated.

(d) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.

There are no pockets or crevices on the outer layer of the packaging where water might collect.

(e) Each feature that is added to the package will not reduce the safety of the package.

Features of the package are evaluated in the SAR, and it was determined that there are none that reduce its safety.

(f) The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use (see §§173.24, 173.24a, and 173.24b).

The package is similar to many other proven casks with many years of operational use in a transport environment. This experience demonstrates that vibrations normally incident to transport will have no effect upon the package.

(g) The materials of construction of the packaging and any components or structure will be physically and chemically compatible with each other and with the package contents. The behavior of the packaging and the package contents under irradiation will be taken into account.

The package is constructed of structural steel and the exterior is primed and painted. As discussed in 2.4.1 of the SAR, there will be no reactions between the package and contents or between the package components.

(h) All valves through which the package contents could escape will be protected against unauthorized operation;

Not applicable. There are no valves in the package.

(i) For transport by air-
(1) The temperature of the accessible surfaces of the package will not exceed 50°C (122°F) at an ambient temperature of 38°C (100°F) with no account taken for insulation;
(2) The integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from -40°C (-40°F) to +55°C (131°F); and
(3) Packages containing liquid contents will be capable of withstanding, without leakage, an internal pressure that produces a pressure differential of not less than 95 kPa (13.8 lb/in^2).

Not Applicable.

173.411(a), (b), and (c) industrial packagings

(a) General. Each industrial packaging must comply with the requirements of this section which specifies packaging tests, and record retention applicable to Industrial Packaging Type 1 (IP-1), Industrial Packaging Type 2 (IP-2), and Industrial Packaging Type 3 (IP-3).

The CNS 8-120B Cask complies with the requirements for an Industrial Packaging Type 1 or Type 2 packaging.

(b) Industrial packaging certification and tests.
(1) Each IP-1 must meet the general design requirements prescribed in §173.410.

See (2) below.

(2) Each IP-2 must meet the general design requirements prescribed in §173.410 and when subjected to the tests specified in §173.465 (c) and (d) or evaluated against these tests by any of the methods authorized by §173.461(a), must prevent:
(i) Loss or dispersal of the radioactive contents; and

(ii) A significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

Compliance was demonstrated in the sections above covering §173.410. As discussed below under §173.465 (c) and (d), the package is evaluated and shown to meet these requirements in the SAR.

(3) Each IP-3 packaging must meet the requirements for an IP-1 and an IP-2, and must meet the requirements specified in §173.412(a) through §173.412(j).

Not Applicable.

(4) Each specification IM 101 or IM 102 portable tank (§§178.270, 178.271, 178.272 of this subchapter) that is certified as meeting the requirements for an IP-2 or IP-3 must:

(i) Satisfy the requirements for IP-2 or IP-3, respectively;

(ii) Be capable of withstanding a test pressure of 265 kPa (37.1 pounds per square inch) gauge;

(iii) Be designed so that any added shielding is capable of withstanding the static and dynamic stresses resulting from normal handling and normal conditions of transport; and

(iv) Be designed so that loss of shielding will not result in a significant increase in the radiation levels recorded at the external surfaces.

Not Applicable.

(5) Each freight container that is certified as meeting the requirements of IP-2 or IP-3, must-

(i) Satisfy the requirements for IP-2 or IP-3, respectively;

(ii) Be designed to conform to the requirements of ISO 1496-3-1995(E), ``Series 1 Freight Containers-Specifications and Testing-Part 3: Tank Containers for Liquids, Gases and Pressurized Dry Bulk'';

(iii) Be designed so that loss of shielding will not result in a significant increase in the radiation levels recorded at the external surfaces if they are subjected to the tests specified in ISO 1496/1-1995(E); and

(iv) For international transportation, have a safety approval plate in conformance with 49 CFR 451.21 through 451.25.

Not Applicable. The CNS 8-120B Cask is not a freight container.

(c) Except for IP-1 packagings, each offeror of an industrial package must maintain on file for at least one year after the latest shipment, and shall provide to the Associate Administrator for Hazardous Materials Safety on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification.

This report will meet the requirements of this paragraph.

173.465 (c) and (d) Type A packaging tests.

(c) Free drop test. The specimen must drop onto the target so as to suffer maximum damage to the safety features being tested, and:

(1) The height of the drop measured from the lowest point of the specimen to the upper surface of the target may not be less than the distance specified in Table 12, for the applicable package mass. The target must be as specified in §173.465(c)(5). Table 12 is as follows:

Table 12.--Free Drop Distance for Testing Packages to Normal Conditions of Transport		
Packaging mass Kilograms (pounds)	*Free drop distance*	
	Meters	*Feet*
<Mass 5000 (11,000)	*1.2*	*4*
5,000 (11,000) Mass to 10,000(22,000)	*0.9*	*3*
10,000 (22,000) Mass to 15,000(33,000)	*0.6*	*2*
>15,000 (33,000) Mass	*0.3*	*1*

Section 2.6.6 of the SAR examines the package for the one foot free drop, side drop, and corner drop. The analyses show that the package can successfully withstand and maintain package integrity for the specified one foot drop.

(2) For packages containing fissile material, the free drop test specified in paragraph (c)(1) of this section must be preceded by a free drop from a height of 0.3 meter (1 foot) on each corner, or in the case of cylindrical packages, onto each of the quarters of each rim.

Not applicable for the CNS 8-120B package.

(3) For fiberboard or wood rectangular packages with a mass of 50 kilograms (110 pounds) or less, a separate specimen must be subjected to a free drop onto each corner from a height of 0.3 meter (1 foot).

Not applicable for the CNS 8-120B package.

(4) For cylindrical fiberboard packages with a mass of 100 kilograms (220 pounds) or less, a separate specimen must be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 meter (1 foot).

Not applicable for the CNS 8-120B package.

(5) The target for the free drop test must be a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

The analyses performed was for a drop onto an essentially unyielding surface as specified in Section 2.6.6 in the SAR.

(d) Stacking test.

(1) The specimen must be subjected for a period of at least 24 hours to a compressive load equivalent to the greater of the following:

(i) Five times the mass of the actual package; or

(ii) The equivalent of 13 kilopascals (1.9 pounds per square inch) multiplied by the vertically projected area of the package.

(2) The compressive load must be applied uniformly to two opposite sides of the specimen, one of which must be the base on which the package would normally rest.

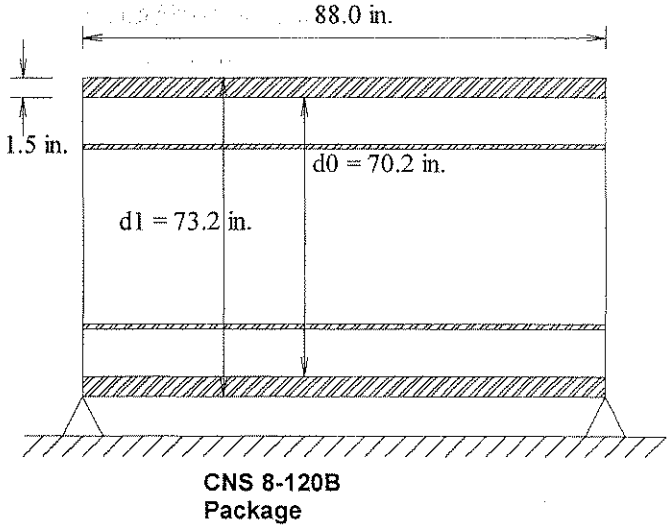
Case (i) above: 5 times package wt. = 5 x 74,000 lbs = 370,000 lbs

Case (ii) above: 1.9 lbs/in^2 x vertically projected area = 1.9 lb/in^2 x 87.5 in x 73.5 in = 12,219 lbs

Case (i) is more severe.

Analyze the cask as a beam with the uniform load of 370,000 lbs applied along the axial length of the wall; assume simple end supports.

The outer shell is fabricated from A516; for conservatism assume where F_{ty} = 32,000 psi



CNS 8-120B Package

$$\sigma_b = \frac{MC}{I}$$

$$M = 5 \times \frac{wl}{8} = \frac{(5)(74{,}000)(88)}{8} = 4.07 \times 10^6 \text{ in-lbs}$$

$$C = \frac{d_1}{2} = \frac{73.2}{2} = 36.6 \text{ in.}$$

$$I = \frac{\pi}{64}\left(d_1^4 - d_o^4\right) = .04906(73.2^4 - 70.2^4) =$$

$$= 2.17 \times 10^5 \text{ in}^4$$

Therefore:

$\sigma_b = \frac{(4.07 \times 10^6 \text{ in-lb})(39 \text{ in})}{2.17 \times 10^5 \text{ in}^4} =$ 732 psi, which yields the following margin of safety:

M.S. = $\frac{32{,}000}{732} - 1 = 42.7$

This calculation is conservative since the structural support of the lead and inner shell are not considered.

The same compressive load acting vertically on the lid is also considered:

$\sigma_c = 5 \times \frac{P}{A} = \frac{5W}{0.785 d_1^2} = \frac{(5)(74{,}000 \text{ lb})}{(3.14 \times 36.6^2)\text{in.}^2 - (3.14 \times 35.1^2)\text{in.}^2} = 1096 \text{psi}$, which yields the

following margin of safety: M.S. = $\frac{32{,}000}{1096} - 1 = 28.2$

4.0 Conclusions and Recommendations

The conclusion of this report is that the CNS 8-120B meets the requirements for an IP-1 and IP-2 package.

5.0 References

5.1 Code of Federal Regulations, Title 49, Parts 100 through 185, October 1, 2000.

5.2 Safety Analysis Report for Chem-Nuclear Systems Model No. CNS 8-120B, Rev. 4, August, 2000.

Approvals Page

Conformance of CNS 8-120B Cask with Specifications for DOT 7A, Type A Packagings

Prepared by:	Signature on File	10/8/02
	Shayne Merritt, Project Engineer	Date
Independent Reviewer:	Signature on File	10/8/02
	Patrick L. Paquin, General Manager	Date

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1.0 Introduction

This report evaluates the CNS 8-120B cask's conformance with 49CFR178.350 "Specification 7A; general packaging, Type A" (Reference 5.1). This report fulfills the requirement of §173.415(a), "Authorized Type A Packages," which specifies that:

> *Each offeror of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification.*

2.0 Discussion

The CNS 8-120B is licensed by the US NRC under Certificate of Compliance USA\9168\B(U). The CNS 8-120B was certified as a Type B package by demonstrating compliance with NRC Type B requirements specified in 10CFR Part 71. Therefore, the CNS 8-120B should readily meet the requirements for a DOT 7A package. Nevertheless, this report examines each regulatory requirement individually to assess the package's conformance to DOT 7A specifications. However, where appropriate, references are made to the Safety Analysis Report for the CNS 8-120B (Reference 5.2) that was prepared to support certification by the NRC.

This Engineering Report evaluates the shipment of solid or liquid radioactive material in this cask when used as a DOT 7A packaging. While the SAR does not specify liquid form as a permitted content, this omission only applies when using the cask as a Type B packaging. The analysis that follows considers the contents to be in liquid or solid state. However, a liner (primary container) is required when shipping liquids (See 49CFR 173.412(k).

The shipper is also responsible for ensuring that the contents do not exceed any of the limits placed on the contents by the analyses in this report or by 49CFR173.431.

The applicable requirements for DOT 7A packagings is given in 49CFR178.350, which is as follows:

> *Each packaging must meet all applicable requirements of subpart B of Part 173 of this subchapter and be designed and constructed so that it meets the requirements of §§173.403, 173.410, 173.412, 173.415 and 173.465 of this subchapter for Type A packaging.*

Also, §173.410 requires packages transporting Class 7 (radioactive) materials to meet Subparts A and B of §173. Therefore, in addition to §178.350, the requirements for DOT 7A packagings are given in the following sections of §173:

Subpart A: General
Subpart B: Preparation of Hazardous Materials for Transportation
173.403: Definitions
173.410: General Design Requirements
173.412: Additional Design Requirements for Type A Packages
173.415: Authorized Type A Packages
173.465: Type A Packaging Tests

The CNS 8-120B is assessed in Section 3.0 below of this report against each the above requirements. (The requirements of §173.403 are not evaluated, since it contains only definitions rather than specifications.) The methods for demonstrating compliance with the test requirements of §173.465 are given in §173.461. These are; (1) performance of tests, (2) reference to a previous, satisfactory, demonstration of compliance, (3) performance of tests with models, or (4) calculations or reasoned evaluation. The primary method used in this report is method number 4, or reference to the cask SAR which also primarily uses method 4.

3.0 Results

49CFR173, Subpart A: General

Subpart A does not include any prescriptive specifications for the package.

Part 173 Subpart B: Preparation of Hazardous Materials for Transportation

173.21 Forbidden materials and packages.

This section contains specifications that are either not applicable to the 8-120B, or that must be met by the shipper relative to contents of a shipment.

173.22 Shipper's responsibility.

This section contains specifications that must be met by the shipper.

173.22a Use of packagings authorized under exemptions.

This section is not applicable to the CNS 8-120B.

173.23 Previously authorized packaging.

This section is not applicable to the CNS 8-120B.

173.24 General requirements for packagings and packages.

(a) Applicability. Except as otherwise provided in this subchapter, the provisions of this section apply to-
(1) Bulk and non-bulk packagings;
(2) New packagings and packagings which are reused; and

(3) Specification and non-specification packagings.

The CNS 8-120B is classified as a bulk packaging, therefore this section is applicable.

(b) Each package used for the shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation-

(1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;

(2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;

(3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.

This specification is demonstrated to be met in Section 2.6.10 in the CNS 8-120B SAR.

(c) Authorized packagings. A packaging is authorized for a hazardous material only if-

(1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the §172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the §172.101 Table and, for specification packagings (but not including UN standard packagings manufactured outside the United States), the specification requirements in parts 178 and 179 of this subchapter; or

(2) The packaging is permitted under, and conforms to, provisions contained in §§171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27, or 176.11 of this subchapter.

Column 8 of the §172.101 Table specifies the applicable packaging specifications and exceptions for a hazardous materials being addressed (for example, Radioactive Material, LSA, n.o.s.).

(d) Specification packagings and UN standard packagings manufactured outside the U.S.

(1) Specification packagings. A specification packaging, including a UN standard packaging manufactured in the United States, must conform in all details to the applicable specification or standard in part 178 or part 179 of this subchapter.

(2) UN standard packagings manufactured outside the United States. A UN standard packaging manufactured outside the United States, in accordance with national or international regulations based on the UN Recommendations on the Transport of Dangerous Goods, may be imported and used and is considered to be an authorized packaging under the provisions of paragraph (c)(1) of this section, subject to the following conditions and limitations:

(i) The packaging fully conforms to applicable provisions in the UN Recommendations on the Transport of Dangerous Goods and the requirements of this subpart, including reuse provisions;

(ii) The packaging is capable of passing the prescribed tests in part 178 of this subchapter applicable to that standard; and

(iii) The competent authority of the country of manufacture provides reciprocal treatment for UN standard packagings manufactured in the U.S.

Not applicable

(e) Compatibility.

(1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly applies to corrosivity, permeability, softening, premature aging and embrittlement.

(2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.

(3) Plastic packagings and receptacles.

(i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.

(ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate of Permeation in Plastic Packagings and Receptacles"). The procedure specified in appendix B of this part must be performed on each plastic packaging or receptacle used for Packing Group I materials. The maximum rate of permeation of hazardous lading through or into the plastic packaging or receptacles may not exceed 0.5 percent for materials meeting the definition of a Division 6.1 material according to §173.132 and 2.0 percent for other hazardous materials, when subjected to a temperature no lower than-

(A) 18 °C (64 °F) for 180 days in accordance with Test Method 1 in appendix B of this part;

(B) 50 °C (122 °F) for 28 days in accordance with Test Method 2 in appendix B of this part; or

(C) 60 °C (140 °F) for 14 days in accordance with Test Method 3 in appendix B of this part.

(iii) Alternative procedures or rates of permeation are permitted if they yield a level of safety equivalent to or greater than that provided by paragraph (e)(3)(ii) of this section and are specifically approved by the Associate Administrator for Hazardous Materials Safety.

(4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or nonhazardous materials if such materials are capable of reacting dangerously with each other and causing-

(i) Combustion or dangerous evolution of heat;

(ii) Evolution of flammable, poisonous, or asphyxiant gases; or

(iii) Formation of unstable or corrosive materials.

(5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

This section contains specifications that must be met by the shipper.

(f) Closures.

(1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation-

(i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and

(ii) The closure is secure and leakproof.

(2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

As discussed in the Chapter 4 of the SAR under the requirements of 10CFR 71 §71.43 and 71.51, the package meets the requirements of this section.

(g) Venting. Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when-

(1) Transportation by aircraft is not involved;

(2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;

(3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and

(4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the §172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

Not applicable.

(h) Outage and filling limits

(1) General. When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packagings are specified in §§173.24a(d) and 173.24b(a), respectively.

(2) Compressed gases and cryogenic liquids. Filling limits for compressed gases and cryogenic liquids are specified in §§173.301 through 173.306 for cylinders and §§173.314 through 173.319 for bulk packagings.

(i) Air transportation. Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in §173.27, except as provided in §171.11 of this subchapter.

This section contains specifications that must be met by the shipper.

173.24a Additional general requirements for non-bulk packagings and packages.

Not applicable; the CNS 8-120B is classified as a bulk packaging.

173.24b Additional general requirements for bulk packagings.

This section contains specifications that must be met by the shipper.

173.25 Authorized packages and overpacks.

Not applicable; this section addresses specifications for overpacks and the package is not classified as an overpack.

173.26 Quantity limitations.

When quantity limitations do not appear in the packaging requirements of this subchapter, the permitted gross weight or capacity authorized for a packaging is as shown in the packaging specification or standard in part 178 or 179, as applicable, of this subchapter.

The permitted capacity and gross weight is given in Chapter 1 of the SAR and marked on the package nameplate.

173.27 General requirements for transportation by aircraft.

Not applicable; the CNS 8-120B is not designed to be transported by aircraft.

173.28 Reuse, reconditioning and remanufacture of packagings.

(a) General. Packagings and receptacles used more than once must be in such condition, including closure devices and cushioning materials, that they conform in all respects to the prescribed requirements of this subchapter. Before reuse, each packaging must be inspected and may not be reused unless free from incompatible residue, rupture, or other damage which reduces its structural integrity.

The package is inspected, as specified in Chapter 7 of the SAR, before each reuse.

(b) Reuse of non-bulk packaging. A non-bulk packaging used more than once must conform to the following provisions and limitations:

Not applicable; the package is classified as a bulk package.

173.29 Empty packagings.

This section contains specifications that must be met by the shipper.

173.30 Loading and unloading of transport vehicles.

A person who loads or unloads hazardous materials into or from a transport vehicle or vessel shall comply with the applicable loading and unloading requirements of parts 174, 175, 176, and 177 of this subchapter.

This section contains specifications that must be met by the shipper.

173.31 Use of tank cars.

Not applicable.

173.32 Requirements for the use of portable tanks.

Not applicable.

173.33 Hazardous materials in cargo tank motor vehicles.

Not applicable.

173.34 Qualification, maintenance and use of cylinders.

Not applicable.

173.35 Hazardous materials in intermediate bulk containers.

Not applicable.

173.40 General packaging requirements for poisonous materials required to be packaged in cylinders.

Not applicable.

173.410: General design requirements.

In addition to the requirements of subparts A and B of this part, each package used for the shipment of Class 7 (radioactive) materials must be designed so that-

(a) The package can be easily handled and properly secured in or on a conveyance during transport.

The cask is equipped with lifting attachments for handling. Cask loading and unloading procedures are specified in Chapter 7 of the SAR. During transport, the cask is tied

down to the trailer deck. The tiedown system is evaluated structurally in Section 2.4.4 of the Safety Analysis Report (SAR).

(b) Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

Section 2.4.3 of the SAR demonstrates that the structural requirements of the lifting attachments are met. Failure of the lifting attachment will not impair the ability of the package to meet other requirements of this subpart. There are no other structural parts of the package that could be used to lift it.

(c) The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.

The external surfaces of the package are free of protruding features, except those necessary for the package to perform its function. The external surfaces are hard and smooth and therefore easily decontaminated.

(d) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.

There are no pockets or crevices on the outer layer of the packaging where water might collect.

(e) Each feature that is added to the package will not reduce the safety of the package.

Features of the package are evaluated in the SAR, and it was determined that there are none that reduce its safety.

(f) The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use (see §§173.24, 173.24a, and 173.24b).

The package is similar to many other proven casks with many years of operational use in a transport environment. This experience demonstrates that vibrations normally incident to transport will have no effect upon the package.

(g) The materials of construction of the packaging and any components or structure will be physically and chemically compatible with each other and with the package contents. The behavior of the packaging and the package contents under irradiation will be taken into account.

The package is constructed of structural steel and the exterior is primed and painted. As discussed in 2.4.1 of the SAR, there will be no reactions between the package and contents or between the package components.

(h) All valves through which the package contents could escape will be protected against unauthorized operation;

Not applicable. There are no valves in the package.

(i) For transport by air-

(1) The temperature of the accessible surfaces of the package will not exceed 50°C (122°F) at an ambient temperature of 38°C (100°F) with no account taken for insulation;

(2) The integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from -40°C (-40°F) to +55°C (131°F); and

(3) Packages containing liquid contents will be capable of withstanding, without leakage, an internal pressure that produces a pressure differential of not less than 95 kPa (13.8 lb/in^2).

Not applicable.

173.412 Additional design requirements for Type A packages.

In addition to meeting the general design requirements prescribed in §173.410, each Type A packaging must be designed so that-

(a) The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed.

Tamper-indicating seals are provided for the closures. Installation of these prior to shipment is required by Chapter 7 of the SAR.

(b) The smallest external dimension of the package is not less than 10 centimeters (4 inches).

The smallest external dimension exceeds 4".

(c) Containment and shielding is maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F). Special attention shall be given to liquid contents and to the potential degradation of the packaging materials within the temperature range.

As discussed in Sections 2.6.1, 2.6.2, 3.4.2, 3.4.3, 3.4.4 and 4.2.2 of the SAR, the components of the package are designed to maintain containment and shielding during transportation and storage in the temperature range specified in this paragraph. Special attention to liquid contents is specified in 49CFR173.412(k). In the event that liquids are being shipped, it is the responsibility of the shipper to verify the liner's ability to perform in the referenced temperature range.

(d) The packaging must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form Class 7 (radioactive) material, as demonstrated in accordance with §173.469, may be considered as a component of the containment system. If the containment system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package.

- As discussed in Sections 1.2.1, 2.4.2, and 4.1.4 of the SAR, the cask is equipped with adequate positive fastening devices that cannot be opened unintentionally.
- The amount of pressure expected during normal conditions of transport, discussed in Sections 2.6.1 and 3.4.4 of the SAR, will not deletiourlously affect the containment system.
- This package is not intended to transport special form radioactive material.

(e) For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis.

When this package contains water and/or organic substances which could radiolytically generate combustible gases, a determination must be made by tests and measurements or by analysis of a representative package that the following criteria are met over a period of time that is twice the expected shipment time:

1. The hydrogen generated must be limited to a molar quantity that would be no more than 5% by volume (or equivalent limits for other inflammable gases) of the secondary container gas void if present at STP (i.e., no more than 0.063 $\frac{g \cdot moles}{ft^3}$ at 14.7 psia and 70°F); or

2. The secondary container and cask cavity must be inerted with a diluent to assure that oxygen is limited to 5% by volume in those portions of the package which could have hydrogen greater than 5%.

For any package delivered to a carrier for transport, the secondary container must be prepared for shipment in the same manner in which determination for gas generation is made. Shipment period begins when the package is prepared (sealed) and must be completed within twice the expected shipment time.

(f) The containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 pounds per square inch).

The following evaluation is performed to show that the cask can safely withstand a reduced external pressure to 3.6 $\frac{\text{lbs.}}{\text{in.}^2}$ absolute. A reduction in external pressure to 3.6 $\frac{\text{lbs.}}{\text{in.}^2}$ absolute, assuming a maximum internal pressure (normal conditions of transport) of 8.95 $\frac{\text{lbs.}}{\text{in.}^2}$ gauge, is equivalent to a net internal pressure of 20.15 $\frac{\text{lbs.}}{\text{in.}^2}$. At a net internal pressure of 20.15 $\frac{\text{lbs.}}{\text{in.}^2}$, the loads on the primary and secondary lid bolts and cask wall will be as follows.

For the primary lid:

$P = \frac{A\,p}{N}$ where A = area of primary lid

N = number of bolts = 20

The load on each of the primary lid bolts will be:

$$P_{PB} = \frac{\pi(73.2)^2}{4}\,\frac{(20.15)}{(20)} = 4240 \text{ lbs.}$$

According to ASTM specification A-354 the tensile strength for the 2"-8UN primary lid bolts is 415,446 lbs.

The margin of safety is:

$$\text{M.S.} = \frac{415{,}446}{4240} - 1 = 96$$

For the secondary lid:

$P = \frac{A\,p}{N}$ where A = area of primary lid

N = number of bolts = 12

The load on each of the secondary lid bolts will be:

$$P_{PB} = \frac{\pi(33.75)^2}{4}\,\frac{(20.15)}{(12)} = 1502 \text{ lbs.}$$

According to ASTM specification A-354 the tensile strength for the 2"-8UN secondary lid bolts is 415,446 lbs.

The margin of safety is:

$$\text{M.S.} = \frac{415{,}446}{1502} - 1 = 275$$

For the cask body:

Conservatively assume that the 20.15 psig internal pressure is entirely contained by the ¾-inch thick inner shell:

$$\text{longitudinal stress} = \frac{P\,R}{t} = \frac{(20.15)\,(62/2)}{0.75} = 833\ \frac{\text{lbs.}}{\text{in.}^2}$$

$$\text{hoop stress} = \frac{P\,R}{2t} = 417\ \frac{\text{lbs.}}{\text{in.}^2}$$

Assuming the stresses are additive, the maximum stress in the cask inner wall is $1250\ \frac{\text{lbs.}}{\text{in.}^2}$. The margin of safety is:

$$\text{M.S.} = \frac{38{,}000}{1032} - 1 = 36$$

These analyses show the cask can safely withstand a reduction of external pressure to 3.6 psi.

(g) Each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.

Not applicable. There are no valves on the package.

(h) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield.

The outer shell and lead act as shielding and contain the inner shell, which forms part of the containment.

(i) Failure of any tie-down attachment that is a structural part of the packaging, under both normal and accident conditions, must not impair the ability of the package to meet other requirements of this subpart.

Failure of the tie-down lugs will be by localized tearing and will not impair the ability of the package to meet other requirements of this subpart.

(j) When evaluated against the performance requirements of this section and the tests specified in §173.465 or using any of the methods authorized by §173.461(a), the packaging will prevent-

(1) Loss or dispersal of the radioactive contents; and
(2) A significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

The tests specified in §173.465 are evaluated in Chapters 2, 3, 4, and 5 of the SAR, where it is shown that the cask can successfully pass these tests without loss or dispersal of the radioactive contents and without a significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test. This is demonstrated by analysis for the conditions specified as allowed by §173.461(a).

(k) Each packaging designed for liquids will-
(1) Be designed to provide for ullage to accommodate variations in temperature of the contents, dynamic effects and filling dynamics;
(2) Meet the conditions prescribed in paragraph (j) of this section when subjected to the tests specified in §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a); and
(3) Either-
(i) Have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material must be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; or
(ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer component in the event that the primary inner component leaks.

1. The liner may be partially filled to accommodate this requirement. However, this is the responsibility of the shipper.
2. Section 2.7.1 of the SAR evaluates the performance of the packaging when it is subjected to the free drop test. Impact energies resulting from the penetration test at 1.7 meters will have no significant effect on the packaging. The impact limiter fully protects both ends of the cask, leaving only the central body exposed. The cask body is manufactured from 2" thick steel plate and backed with 1 7/8" of lead. The ends are comprised of steel 5 ½" thick. No valves, valve covers, or fragile protrusions exist.
3. The cask will serve as the secondary outer containment, while a liner will serve as the primary inner containment. The cask is designed to assure retention of the liquid contents within the cask in the event that the liner leaks.

(l) Each package designed for gases, other than tritium not exceeding 40 TBq (1000Ci) or noble gases not exceeding the A2 value appropriate for the noble gas, will be able to prevent loss or dispersal of contents when the package is subjected to the tests prescribed in §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a).

Not applicable.

173.415 Authorized Type A packages.

The following packages are authorized for shipment if they do not contain quantities exceeding A1 or A2 as appropriate:

(a) DOT Specification 7A (§178.350 of this subchapter) Type A general packaging. Each offeror of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Use of Specification 7A packagings designed in accordance with the requirements of §178.350 of this subchapter in effect on June 30, 1983 (see 49 CFR Part 178 revised as of October 1, 1982), is not authorized after April 1, 1997.

This report should be retained by the shipper to meet the requirements of this paragraph. Note also the exception allowed by §173.431 is that a DOT 7A package can exceed A_1 or A_2 quantities in the contents if the contents are LSA or SCO materials.

(b) Any other Type A packaging that also meets the applicable standards for fissile materials in 10 CFR Part 71 and is used in accordance with §173.471.

Not applicable to the CNS 8-120B package.

(c) Any Type B, B(U) or B(M) packaging authorized pursuant to §173.416.

The CNS 8-120B is a Type B package.

(d) Any foreign-made packaging that meets the standards in IAEA "Safety Series No. 6" and bears the marking "Type A" and was used for the import of Class 7 (radioactive) materials. Such packagings may be subsequently used for domestic and export shipments of Class 7 (radioactive) materials provided the offeror obtains the applicable documentation of tests and engineering evaluations and maintains the documentation on file in accordance with paragraph (a) of this section. These packagings must conform with requirements of the country of origin (as indicated by the packaging marking) and the IAEA regulations applicable to Type A packagings.

Not applicable to the CNS 8-120B package.

173.465 Type A packaging tests.

(a) The packaging, with contents, must be capable of withstanding the water spray, free drop, stacking and penetration tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are met.

(b) Water spray test. The water spray test must precede each test or test sequence prescribed in this section. The water spray test must simulate exposure to rainfall of

approximately 5 centimeters (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test must be such that the water has soaked in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively.

As discussed in Section 2.1.1.1 of the SAR, the exterior of the package is fabricated from carbon steel. The closure lids are bolted closed and sealed with gaskets. Hence, a water spray will have negligible effects on the package.

(c) Free drop test. The specimen must drop onto the target so as to suffer maximum damage to the safety features being tested, and:

(1) The height of the drop measured from the lowest point of the specimen to the upper surface of the target may not be less than the distance specified in Table 12, for the applicable package mass. The target must be as specified in §173.465(c)(5). Table 12 is as follows:

Table 12.--Free Drop Distance for Testing Packages to Normal Conditions of Transport		
Packaging mass Kilograms (pounds)	*Free drop distance*	
	Meters	*Feet*
<Mass 5000 (11,000)	*1.2*	*4*
5,000 (11,000) Mass to 10,000(22,000)	*0.9*	*3*
10,000 (22,000) Mass to 15,000(33,000)	*0.6*	*2*
>15,000 (33,000) Mass	*0.3*	*1*

Section 2.6.6 of the SAR examines the package for the one-foot free drop and corner drop. The analyses show that the package can successfully withstand and maintain package integrity for the specified one-foot drop.

(2) For packages containing fissile material, the free drop test specified in paragraph (c)(1) of this section must be preceded by a free drop from a height of 0.3 meter (1 foot) on each corner, or in the case of cylindrical packages, onto each of the quarters of each rim.

Not applicable for the CNS 8-120B package.

(3) For fiberboard or wood rectangular packages with a mass of 50 kilograms (110 pounds) or less, a separate specimen must be subjected to a free drop onto each corner from a height of 0.3-meter (1-foot).

Not applicable for the CNS 8-120B package.

(4) For cylindrical fiberboard packages with a mass of 100 kilograms (220 pounds) or less, a separate specimen must be subjected to a free drop onto each of the quarters of each rim from a height of 0.3-meter (1-foot).

Not applicable for the CNS 8-120B package.

(5) The target for the free drop test must be a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

The analyses performed was for a drop onto an essentially unyielding surface, according to Section 2.6.6 of the SAR.

(d) Stacking test.

(1) The specimen must be subjected for a period of at least 24 hours to a compressive load equivalent to the greater of the following:

(i) Five times the mass of the actual package; or

(ii) The equivalent of 13 kilopascals (1.9 pounds per square inch) multiplied by the vertically projected area of the package.

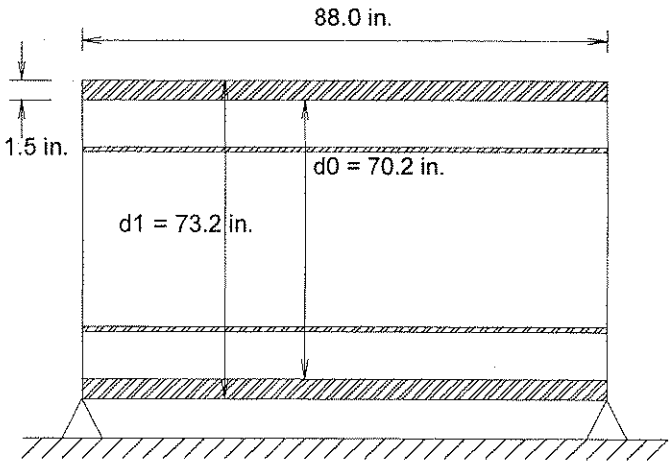
(2) The compressive load must be applied uniformly to two opposite sides of the specimen, one of which must be the base on which the package would normally rest.

Case (i) above: 5 times package wt. = 5 x 74,000 lbs. = 370,000 lbs.

Case (ii) above: 1.9 lbs/in^2 x vertically projected area = 1.9 lb/in^2 x 88.0 in x 73.2 in = 12,239 lbs.

Case (i) is more severe.

Analyze the cask as a beam with the uniform load of 370,000 lbs. applied along the axial length of the wall; assume simple end supports.



CNS 8-120B Package

The outer shell is fabricated from A516; for conservatism assume where F_{ty} = 32,000 psi

$$\sigma_b = \frac{MC}{I}$$

$$M = 5 \times \frac{wl}{8} = \frac{(5)(74{,}000)(88)}{8} = 4.07 \times 10^6 \text{ in-lbs.}$$

$C = \frac{d_1}{2} = \frac{73.2}{2} = 36.6$ in.

$I = \frac{\pi}{64}(d_1^4 - d_o^4) = .04906(73.2^4 - 70.2^4) =$

$= 2.17 \times 10^5$ in^4

Therefore:

$\sigma_b = \frac{(4.07 \times 10^6 \text{ in-lb})(39 \text{ in})}{2.17 \times 10^5 \text{ in}^4} =$ 732 psi, which yields the following margin of safety:

M.S. $= \frac{32{,}000}{732} - 1 = 42.7$

This calculation is conservative since the structural support of the lead and inner shell is not considered.

The same compressive load acting vertically on the lid is also considered:

$\sigma_c = 5 \times \frac{P}{A} = \frac{5W}{0.785 d_1^2} = \frac{(5)(74{,}000 \text{ lb})}{(3.14 \times 36.6^2)\text{in.}^2 - (3.14 \times 35.1^2)\text{in.}^2} = 1096 \text{ psi}$, which yields the

following margin of safety:

M.S. $= \frac{32{,}000}{1096} - 1 = 28.2$

(e) Penetration test. For the penetration test, the specimen must be placed on a rigid, flat, horizontal surface that will not move significantly while the test is being performed.

(1) A bar of 3.2 centimeters (1.25 inches) in diameter with a hemispherical end and a mass of 6 kilograms (13.2 pounds) must be dropped and directed to fall with its longitudinal axis vertical, onto the center of the weakest part of the specimen, so that, if it penetrates far enough, it will hit the containment system. The bar may not be significantly deformed by the test; and

(2) The height of the drop of the bar measured from its lower end to the intended point of impact on the upper surface of the specimen must be 1 meter (3.3 feet) or greater.

Impact energies resulting from the penetration test at 1.0 meter will have no significant effect on the packaging. The impact limiter fully protects both ends of the cask, leaving only the central body exposed. The cask body is manufactured from 2" thick steel plate and backed with 1 7/8" of lead. The ends are comprised of steel 5 ½" thick. No valves. Valve covers, or fragile protrusions exist.

4.0 Conclusions and Recommendations

The requirements of §178.350(b) are that:

Each Specification 7A packaging must be marked on the outside "USA DOT 7A Type A" and "Radioactive Material."

The conclusion of this report is that the CNS 8-120B meets the specification requirements for a DOT 7A package and can be marked as required by §178.350(b).

5.0 References

5.1 Code of Federal Regulations, Title 49, Parts 100 through 185, October 1, 2000.

5.2 Safety Analysis Report for Chem-Nuclear Systems Model No. CNS 8-120B, Rev. 4, August, 2000.

Section 3

Typical User Registration Letter

Sample User Registration Letter

Date

U.S. Nuclear Regulatory Commission
Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555

Gentlemen:

Pursuant to the requirements of 10 CFR 71.17, _____(organization's name), as holder of License No. _____, wishes to register as a user of the 8-120B radioactive materials shipping cask. Package identification number for this cask is USA/9168/B(U)-96, NRC Docket No. 71-9168.
.

It is requested that future information for this package be forwarded to the following individual:

_____
Name

_____
Title

_____
Organization

_____
Organization's Address

Sincerely,

_____
Name

_____
Title

cc: Energy*Solutions*
Document Control
Suite 100, Center Point II
100 Center Point Circle
Columbia, SC 29210

Section 4

Safety Analysis Report
(Sections 1, 7, and 8)

SAFETY ANALYSIS REPORT

For

MODEL 8-120B TYPE B SHIPPING PACKAGING

CONSOLIDATED REVISION 7

November 2013

Submitted by:

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REVISION CONTROL SHEET

TITLE: Safety Analysis Report for Model 8-120B Type B Shipping Packaging

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1.0 GENERAL INFORMATION

1.1 INTRODUCTION

This Safety Analysis Report describes a reusable shipping package designed to protect radioactive material from both normal conditions of transport and hypothetical accident conditions. The package is designated the Model 8-120B package.

1.2 PACKAGE DESCRIPTION

1.2.1 PACKAGING

The package consists of a steel and lead cylindrical shipping cask with a pair of cylindrical foam-filled impact limiters installed on each end. The package configuration is shown in Figure 1-1. The internal cavity dimensions are 61 $\frac{13}{16}$ inches in diameter and 74 ⅞ inches high. The cylindrical cask body is comprised of a 1½ inch thick external steel shell and a ¾ inch internal steel shell. The annular space between the shells is filled with 3.35 inch thick lead. The base of the cask consists of two 3¼ inch thick flat circular steel plates. The cask lid consists of two 3¼ inch thick flat circular steel plates. The lid is fastened to the cask body with twenty 2-8 UN bolts. There is a secondary lid in the middle of the primary lid. This secondary lid is attached to the primary lid with twelve 2-8 UN bolts. A thermal shield protects the secondary lid. The thermal-shield consists of two polished stainless-steel plates that are separated by a thin air gap with stand-offs which provide an additional air gap above the secondary lid. The thermal-shield assembly is attached to the secondary lid lifting lugs with hitch-pins.

The impact limiters are 102 inches in outside diameter and extend 22 inches beyond each end of the cask. There is a 50.0 inch diameter void at each end. Each impact limiter has an external shell, fabricated from ductile low carbon steel, which allows it to withstand large plastic deformations without fracturing. The volume inside the shell is filled with a crushable shock and thermal insulating polyurethane foam. The polyurethane is sprayed into the shell and allowed to expand until the void is completely filled. The foam bonds to the shell, which creates a unitized construction for the impact limiters. The impact limiters' skin is 12 gage steel, including the upper impact limiter's weather cover. The lower impact limiter has a ½" thick steel cover plate.

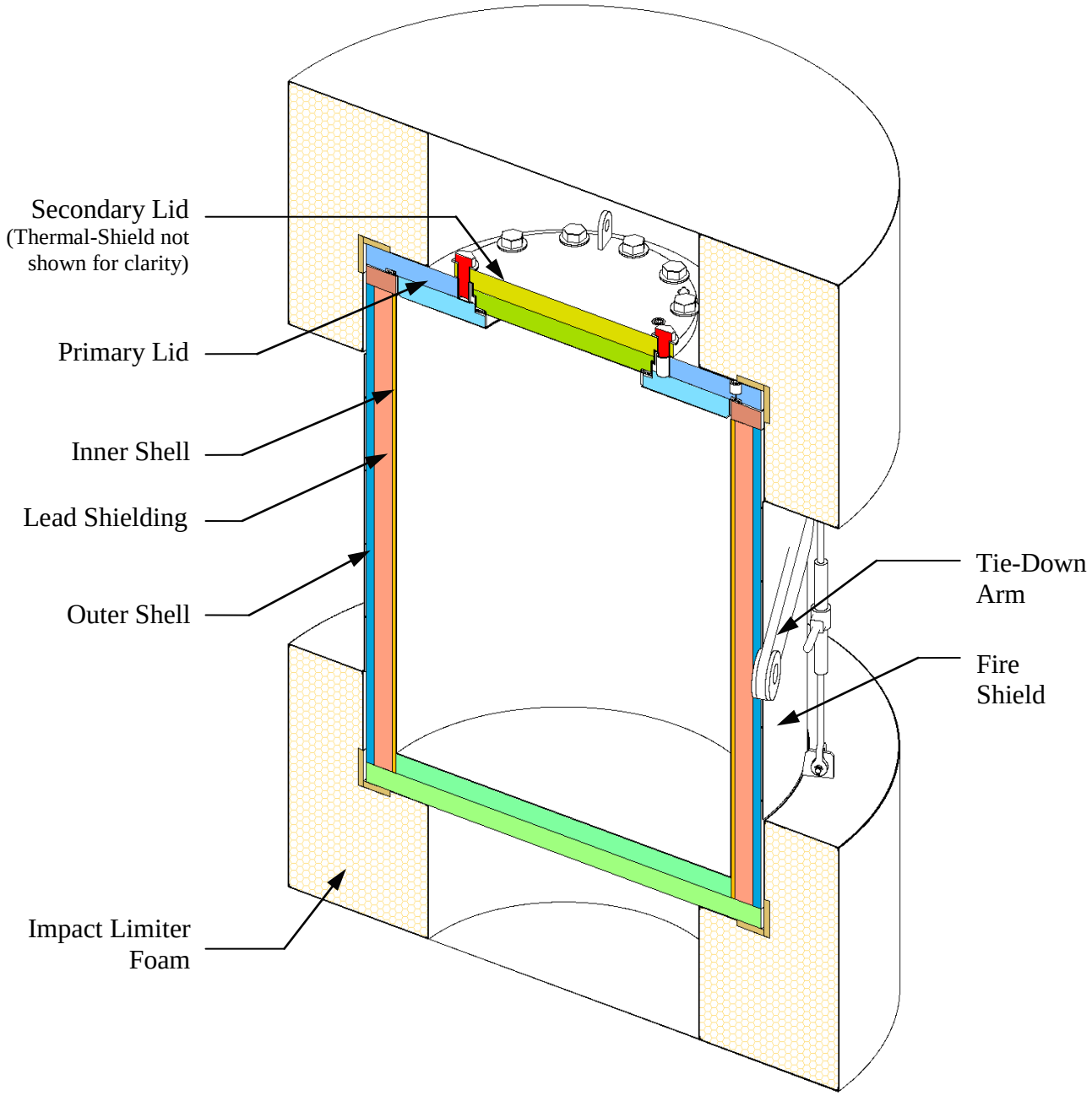

Figure 1-1 - Features of the 8-120B Cask

The properties of the foam are further described in Section 2.2. The top and bottom impact limiters are connected together by eight one-inch diameter ratchet binders. This serves to hold the impact limiters in place on the cask during shipment, while allowing easy removal of the impact limiters for loading and unloading operations.

A general arrangement drawing of the package is included in Appendix 1.3. It shows the package dimensions as well as all materials of construction.

1.2.1.1 Containment Vessel

The containment vessel is defined as the inner steel shell of the cask body together with closure features comprised of the lower surface of the cask primary lid and 20 equally spaced 2-8 UN closure bolts and the lower surfaces of the cask secondary lid and the 12 equally spaced 2-8 UN closure bolts.

1.2.1.2 Neutron Absorbers

There are no materials used as neutron absorbers or moderators in the package.

1.2.1.3 Package Weight

Maximum gross weight for the package is 74,000 lbs. including a maximum payload weight of 14,150 lbs.

1.2.1.4 Receptacles

There are no receptacles on this package.

1.2.1.5 Vent and Test Ports

Pressure test ports with manual venting features exist between the twin o-ring seals for both the primary and secondary lids. This facilitates leak testing the package in accordance with ANSI N14.5.

The vent port is provided with the same venting features for venting pressures within the containment cavity, which may be generated during transport, prior to lid removal. Each port is sealed with an elastomer gasket. Specification information for all seals and gaskets is contained in Chapter 4.

1.2.1.6 Lifting Devices

Lifting devices are a structural part of the package. From the General Arrangement Drawing shown in Appendix 1.3, it can be seen that two removable lifting ears are provided, which attach to the cylindrical cask body. Three lifting lugs are also provided for removal and handling of the lid. Similarly, three lugs are provided for removal and handling of the secondary lid. Refer to Section 2.5.1 for a detailed analysis of the structural integrity of the lifting devices.

1.2.1.7 Tie-downs

From the General Arrangement Drawing, shown in Appendix 1.3, it can be seen that the tie-down arms are an integral part of the external cask shell. Consequently, tie-down arms are considered a structural part of the package. Refer to Section 2.5.2 for a detailed analysis of the structural integrity of the tie-down arms.

1.2.1.8 Heat Dissipation

There are no special devices used for the transfer or dissipation of heat.

1.2.1.9 Coolants

There are no coolants involved.

1.2.1.10 Protrusions

There are no outer or inner protrusions except for the tie-down arms described above. Lifting lugs are removed prior to transport.

1.2.1.11 Shielding

Cask walls provide a shield thickness of 3.35 inches of lead and 2¼ inches of steel. Cask ends provide a minimum of 6½ inches of steel. The contents will be limited such that the radiological shielding provided (4½ inches lead equivalent) will assure compliance with DOT and IAEA regulatory requirements.

1.2.1.12 Configurations

There are three configurations of the 8-120B cask.

- Configurations 1 and 2 were fabricated per the previously approved drawing Rev. 13 and differ mainly in the inclusion (Configuration 1) or lack (Configuration 2) of the optional drain port. Configuration 1 now includes sealing the drain port with the insertion and welding of a rod in the drain port. Acceptance Testing of Configurations 1 and 2 are described in Section 8.1. Fabrication of Configurations 1 or 2 after April 1, 1999 are not permitted.
- Configuration 3 does not have a drain port and the base plate is fabricated differently than Configurations 1 and 2. Acceptance Testing of Configuration 3 is described in Section 8.2.
- Configurations 1, 2 and 3 have the same Operations and Maintenance requirements and are described in Sections 7.0 and 8.3 respectively

All configurations have the same structural, thermal, containment, shielding, and criticality evaluations.

1.2.2 CONTENTS OF PACKAGING

1.2.2.1 Type form of material:

- Byproduct, source, or special nuclear material, in the form of dewatered resins, solids, including powdered or dispersible solids, or solidified material, contained within secondary container(s); or
- Radioactive material in the form of neutron activated metals or metal oxides in solid form contained within secondary container(s).

1.2.2.2 Maximum quantity of material per package:

Type B quantity of radioactive material not to exceed $3000A_2$, 200 thermal watts, and 14,430 pounds including weight of the contents, secondary container(s) and shoring. The contents may include fissile materials provided at least one of the paragraphs (a) through (f) of 10 CFR 71.15 is met. Materials producing more than 1×10^5 neutrons/sec in the total contents, other than fissile materials as allowed in the preceding sentence, are not authorized.

The activity of beta and gamma emitting radionuclides shall not exceed the limit determined per the procedure in Chapter 7 Attachment 1.

Powdered or dispersible solid radioactive materials must have a mass of at least 60 grams or a specific activity of 50 A_2/g or less.

1.2.2.3 Loading Restrictions

Contents shall be packaged in secondary containers. Except for close fitting contents, shoring must be placed between the secondary containers or activated components and the cask cavity to prevent movement during accident conditions of transport.

Explosives, non-radioactive pyrophorics, and corrosives (pH less than 2 or greater than 12.5), are prohibited. Pyrophoric radionuclides may be present only in residual amounts less than 1 weight percent. Materials that may auto-ignite or change phase (i.e., change from solid to liquid or gas) at temperatures less than 350°F, not including water, shall not be included in the contents. In addition, as required by 10 CFR 71.43 (d), the contents shall not include any materials that may cause any significant chemical, galvanic, or other reaction.

Powdered solids shipments shall be performed only when the most recent periodic leak test meets the requirements of Chapter 4, Section 4.9. Powdered solid radioactive material shall not include radioactive forms of combustible metal hydrides, combustible elemental metals, i.e., magnesium, titanium, sodium, potassium, lithium, zirconium, hafnium, calcium, zinc, plutonium, uranium, and thorium, or combustible non-metals, i.e., phosphorus.

For any package containing water and/or organic substances which could radiolytically generate combustible gases, a determination must be made that , over a period of time that is twice the expected shipping time, the hydrogen generated must be limited to a molar quantity that would be no more than 5% by volume (or equivalent limits for other inflammable gases) of the

secondary container gas void if present at STP (i.e., no more than 0.063 g-moles/ft^3 at 14.7 psia and 70°F).

The determination of hydrogen generation will be made using the methods in NUREG/CR-6673, *Hydrogen Generation in TRU Waste Transportation Packages*. NUREG/CR-6673 has equations that allow prediction of the hydrogen concentration as a function of time for simple nested enclosures and for packages containing multiple contents packaged within multiple nested confinement layers. The inputs to these equations include the bounding effective $G(H_2)$-value for the contents, the $G(H_2)$-values for the packaging material(s), the void volume in the containment vessel and in the confinement layers (when applicable), the temperature when the package was sealed, the temperature of the package during transport, and the contents decay heat.

For any package delivered to a carrier for transport, the secondary container must be prepared for shipment in the same manner in which the determination for gas generation is made. Shipment period begins when the package is prepared (sealed) and must be completed within twice the expected shipping time.

For any package containing materials with radioactivity concentration not exceeding that for LSA and shipped within 10 days of preparation, or within 10 days of venting the secondary container, the gas generation determination above need not be made and the shipping time restriction does not apply.

1.2.3 SPECIAL REQUIREMENTS FOR PLUTONIUM

Any contents that contain more than 0.74 TBq (20 Ci) of plutonium must be in solid form.

1.2.4 OPERATIONAL FEATURES

Refer to the General Arrangement Drawing of the package in Appendix 1.3. There are no complex operational requirements associated with the package

1.3 APPENDIX

8-120B Shipping Cask Drawings

- C-110-E-0007, *8-120B Shipping Cask*, Revision 19
- DWG-CSK-12CV01-EG-0001, 8-120B Cask Secondary Lid Thermal-Shield Details, Revision 3

Drawings withheld on the basis that they are Security-Related Information

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Sections 2.0 through 6.0 are not included in the Cask Book since they are not required for the operations and maintenance of the package and need not be in the possession of the licensee during use of the package.

7.0 OPERATING PROCEDURE

This chapter describes the general procedure for loading and unloading of the 8-120B Cask.

The maximum permissible activity is the lesser of the activity determined by: 1) Attachment 1 for beta and gamma emitters, 2) 3000 A_2, or 3) having a decay heat of 200 watts. Radioactive contents are to be transported as exclusive use, per 10 CFR 71.4.

For contents that could radiolytically generate combustible hydrogen, see Attachment 2 for instructions on determination of hydrogen concentration.

Powdered solids shipments require that the most recent periodic leak test meets the requirements of Section 8.3.2.1 for leaktight status.

7.1 LOADING THE PACKAGING

NOTE: Prior to loosening the impact limiter ratchet binders, inspect the exterior of the package for damage, e.g., large dents, gouges, tears to the impact limiter skin and thermal shield. Contact EnergySolutions if damage is present. The cask may not be used as a Type B package until the damage is assessed by Energy*Solutions* and repairs, if required, are made to achieve conformance with the drawings listed in the CoC.

7.1.1 Impact Limiter Removal

7.1.1.1 Loosen and disconnect ratchet binders from upper impact limiter.

7.1.1.2 Using suitable lifting equipment, remove upper impact limiter assembly. Care should be exercised to prevent damage to impact limiter during handling and storage.

7.1.2 Secondary Lid Thermal Shield Removal

7.1.2.1 Remove the ball lock pins from each of the three retaining pins and remove the retaining pins from secondary lid lift lugs.

7.1.2.2 Using suitable lifting equipment, remove the secondary lid thermal shield. Care should be taken to prevent damage to thermal shield during handling and storage.

7.1.3 Determine if cask must be removed from trailer for loading purposes. To remove cask from trailer:

7.1.3.1 Disconnect cask to trailer tie-down equipment.

7.1.3.1.1 Inspect cask lifting ear bolts for defects. Obtain replacement bolts as specified on the drawing listed in 5(a)(3) of the CoC

for any bolts that show cracking or other visual signs of distress.

7.1.3.1.2 Inspect cask lifting ear threaded holes for defects. Contact Energy*Solutions* if any bolt holes show signs of cracking or visual signs of distress.

7.1.3.2 Attach cask lifting ears and torque bolts to 200 ft-lbs. ± 20 ft-lbs. lubricated.

NOTE: The cables used for lifting the cask must have a true angle, with respect to the horizontal of not less than 60°.

7.1.3.3 Using suitable lifting equipment, remove cask from trailer and the lower impact limiter and place cask in level loading position.

NOTE: In certain circumstances, loading may be accomplished through the secondary lid, into a pre-positioned waste liner that has been properly shored or into pre-positioned shoring, while the primary lid remains on the cask. Alternate "(A)" steps have been included to accommodate this situation.

7.1.4 Loosen and remove the twenty (20) bolts, which secure the primary lid to cask body.

7.1.4A Loosen and remove the twelve (12) bolts, which secure the secondary lid to the primary lid.

7.1.5 Inspect the bolts for defects. Obtain replacement bolts as specified on the drawing listed in 5(a)(3) of the CoC for any bolts that show cracking or other visual signs of distress.

NOTE: The cables used for lifting either lid must have a true angle, with respect to the horizontal, of not less than 45^{o}.

7.1.6 Remove primary lid from cask body using suitable lifting equipment. Care should be taken during lid handling operations to prevent damage to cask or lid seal surfaces.

7.1.6A Remove secondary lid from cask body using suitable lifting equipment. Care should be taken during lid handling operations to prevent damage to cask or lid seal surfaces.

7.1.7 Inspect the bolts holes for defects. Contact Energy*Solutions* for any bolt holes that show signs of cracking or visual signs of distress.

7.1.8 Inspect cask interior for damage, loose materials or moisture. Clean and inspect seal surfaces. Replace seals when defects or damage is noted which may preclude proper sealing. Contact EnergySolutions if damage is present.

NOTE: Radioactively contaminated liquids may be pumped out or removed by use of an absorbent material. Removal of any material from inside the cask shall be performed under the supervision of qualified health physics personnel with the necessary H.P. monitoring and radiological health safety precautions and safeguards.

NOTE: When seals are replaced, leak testing is required as specified in Section 8.3.2.1.

NOTE: Verify intended contents meet the requirements of the Certificate of Compliance.

NOTE: Ensure the contents, secondary container, and packaging are chemically compatible, i.e., will not react to produce flammable gases.

7.1.9 Place disposable liner, drums or other containers into the pre-positioned shoring and install additional shoring or bracing, if necessary, to restrict movement of contents during normal transport.

7.1.9A Process liner as necessary, and cap using standard capping devices. Provide shoring if necessary to limit movement during transport, or if required by the radiological qualification procedure of Attachment 1.

7.1.10 Perform two independent physical verifications of the secondary container's closure system to ensure that it is properly closed and secured. This requirement is waived[1] for uniformly distributed resins, filters, and for solidified wastes with no dimension less than 1 cm.

7.1.11 Clean and inspect lid seal surfaces.

7.1.12 Replace the primary lid on the cask body. Secure the lid by hand tightening the twenty (20) primary lid bolts.

7.1.12.1 Torque, using a star pattern, the twenty (20) primary lid bolts (lubricated) to 250 ft-lbs. ± 25 ft-lbs.

[1] The basis for double verification is to assure that small, high-specific activity particles do not have the potential to migrate up into the annular gap between the primary lid and the cask bolting flange. Payloads containing any form of isotope sources, or containing highly activated fines, swarf, crud, or other hot particles less than 1 cm in size are therefore not exempt.

7.1.12.2 Re-Torque, using a star pattern, the twenty (20) primary lid bolts (lubricated) to 500 ft-lbs. ± 50 ft-lbs.

7.1.12A Replace the secondary lid on the primary lid. Secure the lid by hand tightening the twelve (12) secondary lid bolts.

7.1.12.1A Torque, using a star pattern, the twelve (12) secondary lid bolts (lubricated) to 250 ft-lbs. ± 25 ft-lbs.

7.1.12.2A Re-torque, using a star pattern, the twelve (12) secondary lid bolts (lubricated) to 500 ft-lbs. ± 5 0 ft-lbs.

7.1.13 Replace the vent port cap screw and seal (if removed) and torque to 20 ft-lbs. ± 2 ft-lbs.

7.1.14 Leak test the primary lid and secondary lid O-rings and the vent port, in accordance with Section 8.3.2.2, prior to every shipment.[2]

7.1.15 If cask has been removed from trailer, proceed as follows to return cask to trailer:

7.1.15.1 Using suitable lifting equipment, lift and position, cask into lower impact limiter on trailer in the same orientation as removed.

7.1.15.2 Unbolt and remove cask lifting ears.

7.1.15.3 Reconnect cask to trailer using tie-down equipment.

7.1.16 Installation of Upper Impact Limiter and Secondary Lid Thermal Shield

7.1.16.1 Using suitable lifting equipment, lift, inspect for damage and install the secondary lid thermal shield.

7.1.16.2 Install the three secondary lid thermal shield retaining pins into the secondary lid lift lugs and insert the ball lock pins into the retaining pins.

7.1.16.3 Using suitable lifting equipment, lift, inspect for damage and install upper impact limiter on cask in the same orientation as removed.

[2] The pre-shipment leak test of the primary lid, secondary lid, and vent port seals is required before every 8-120B cask shipment, even if the lid bolts or vent port socket head cap screw have not been loosened during loading operations. This requirement is necessary to assure that the 8-120B cask containment system is properly assembled prior to every shipment since it should not be assumed that the containment system is properly assembled prior to loading operations.

7.1.17 Attach and hand tighten ratchet binders between upper and lower impact limiter assemblies.

7.1.18 Cover lift lugs as required.

7.1.19 Inspect package for proper placards and labeling.

7.1.20 Complete required shipping documentation.

7.1.21 Prior to shipment of a loaded package, the following shall be confirmed:

7.1.21.1 That the licensee who expects to receive the package containing materials in excess of Type A quantities specified in 10 CFR 20.1906(a) meets and follows the requirements of 10 CFR 20.1906, as applicable.

7.1.21.2 That trailer placarding and package labeling meet DOT specifications (49 CFR 172).

7.1.21.3 That the provisions of 10 CFR 71.87 are met including that the external radiation dose rates are less than or equal to 200 millirem per hour (mrem/hr) at the surface and less than or equal to 10 mrem/hr at 2 meters in accordance with 10 CFR 71.47 by performing radiation surveys. These surveys should be sufficient to ensure that a non-uniform distribution of radioactivity does not cause the surface or 2m limit to be exceeded.

The SAR thermal analysis demonstrates that by meeting the 200w decay heat limit, the temperature requirement of 10 CFR 71.43(g) is met. No temperature survey is required.

7.1.21.4 That all security seals are properly installed.

7.1.21.5 Prior to shipping a loaded package, inspect the exterior of the cask for damage, e.g., large dents, gouges, tears to the impact limiter skin and thermal shield. Contact Energy*Solutions* if damage is present.

7.1.21.6 Prior to shipping a loaded package, confirm that the periodic leak test described in Section 8.3.2.1 has been performed. For shipments of powdered radioactive materials, confirm that most recent periodic leak test of the 8-120B demonstrated leaktight status.

7.2 UNLOADING THE PACKAGE

In addition to the following sequence of events for unloading a package, packages containing quantities of radioactive material in excess of Type A quantities specified in 10 CFR 20.1906(a)

shall be received, monitored, and handled by the licensee receiving the package in accordance with the requirements of 10 CFR 20.1906, as applicable. Identification of packages containing greater than Type A quantities can be made by review of the shipping papers accompanying the shipment.

7.2.1 Move the unopened package to an appropriate level unloading area.

7.2.2 Perform an external examination of the unopened package. Record any significant observations.

7.2.3 Remove security seal(s), as required.

7.2.4 Impact Limiter Removal

7.2.4.1 Loosen and disconnect ratchet binders from upper impact limiter.

7.2.4.2 Using suitable lifting equipment, remove upper impact limiter assembly. Care should be exercised to prevent damage to impact limiter during handling and storage.

7.2.5 Secondary Lid Thermal Shield Removal

7.2.5.1 Remove the ball lock pins from each of the three retaining pins and remove the retaining pins from secondary lid lift lugs.

7.2.5.2 Using suitable lifting equipment, remove the secondary lid thermal shield. Care should be taken to prevent damage to thermal shield during handling and storage.

7.2.6 If cask must be removed from trailer, refer to Step 7.1.3.

7.2.7 Loosen and remove the twenty (20) primary lid bolts.

NOTE: The cables used for lifting the lid must have a true angle with respect to the horizontal of not less than 45 degrees.

7.2.8 Using suitable lifting equipment, lift lid from cask using care during handling operations to prevent damage to cask and lid seal surfaces.

7.2.9 Remove contents.

NOTE: Radioactively contaminated liquids may be pumped out or removed by use of an absorbent material. Removal of any material from inside the cask shall be performed under the supervision of qualified health physics personnel with the necessary H.P. monitoring and radiological health safety precautions and safeguards.

7.2.10 Assemble packaging in accordance with loading procedure (7.1.10 through 7.1.19).

7.3 PREPARATION OF EMPTY PACKAGING FOR TRANSPORT

7.3.1 Confirm the cavity is empty of contents are far as practicable

7.3.2 Survey the interior; decontaminate the interior if the limits of 49 CFR 173.428(d) are exceeded

7.3.3 Install the lid.

7.3.4 Install the lid closure bolts.

7.3.5 Torque, using a star pattern, the twenty (20) primary lid bolts (lubricated) to 250 ft-lbs. ± 25 ft-lbs.

7.3.6 Re-Torque, using a star pattern, the twenty (20) primary lid bolts (lubricated) to 500 ft-lbs. ± 50 ft-lbs.

7.3.7 Re-install the vent port cap screw with the seal. Torque the vent port cap screw to 20±2 ft-lbs.

7.3.8 Decontaminate the exterior surfaces of the package as necessary.

7.3.9 Inspect the exterior and confirm it is unimpaired.

7.3.10 Using suitable lifting equipment, lift, inspect for damage and install the secondary lid thermal shield.

7.3.11 Install the three secondary lid thermal shield retaining pins into the secondary lid lift lugs and insert the ball lock pins into the retaining pins.

7.3.12 Using suitable lifting equipment, lift, inspect for damage and install upper impact limiter on cask in the same orientation as removed

7.3.13 Attach the tamper-indicating seals.

7.3.14 Confirm the requirements of 49 CFR 173.428 are met.

Attachment 1
Determination of Acceptable Beta and Gamma Source Strength

(see Chapter 5 for the derivation of the beta and gamma source strength limits)

Background and Definitions

8-120B contents (payloads) have acceptable beta and gamma sources when they can be shown to meet the requirements in Table 7-1 using the procedure described in this Attachment. Source qualification is based on a sum-of-fractions method, where sources are broken down into separate gamma energy lines and compared to the corresponding limit for that group. For some payloads, it may be necessary to subdivide the payload into separate items, determining fractions for each item by energy group then summing the fractions to determine acceptability.

Table 7-1 categorizes the limits into source strength (γ/sec) and source strength density (γ/sec·g). For each energy, the fraction to be summed is the lowest of the γ/sec and γ/sec·g fractions. Table 7-1 has five columns of limits, denoted ❶ through ❺. Depending on the nature of the payload, the user must select a pair of columns to use for each payload item, one γ/sec column and one γ/sec·g column. The "general" payload columns (❶,❷) are the most conservative and are suitable for any payload item. Higher limits are acceptable for special cases where a reduced volume item is shored about the centroid of the package cavity (e.g., an isotope source). These are termed "discrete" payload items, and are distinguished as follows:

- Use the 2.5 ft^3 limits (❸,❹) when the payload item has a volume of 2.5 ft^3 (70,792 cm) or less, a height of 28 inches (71.16 cm) or less, and a diameter of 17.65 inches (44.84 cm) or less, and is shored at the centroid of the cavity.
- Use the 55-gallon limits (❸,❺) when the payload item has a volume of 7.7 ft^3 (218,868 cm^3) or less, a height of 33.5 inches (85.1 cm) or less, and a diameter of 25.7 inches (65.3 cm) or less, and is shored at the centroid of the cavity.
- If the payload item does not meet the requirements of either the 2.5 ft^3 or 55-gallon definitions, regardless of shoring, then use the γ/sec limit for general sources ❶, and the general γ/sec·g limit ❷.

Source limits from Table 7-1 may not be interpolated in energy. The proper procedure for gammas (and for equivalent bremsstrahlung gammas) is to round source energies up to the next higher energy level in Table 7-1.

For the purpose of qualification, the total γ/sec source strength for the entire payload is determined for each gamma energy group. Then, for each gamma energy group, the γ/sec·g source strength density is conservatively determined based on the highest source strength ("hottest") portion of the payload. Averaging of the source strength density is not allowed, either between payload items or within payload items. This conservative approach ensures that package dose rate limits will be met, even for payloads for which the source strength density is not uniform within its volume/mass, since the analysis and qualification is based on the highest source strength density material that occurs anywhere within the payload. Once the applicable γ/sec source strength and γ/sec·g source strength density are determined for the payload, they are compared to the corresponding limits that are determined as discussed above.

For some payloads, use of the highest source strength density may be inappropriately conservative (e.g., payloads with a small mass of high source strength density material within a large mass of much lower source strength density material). The qualification methodology takes these payloads into consideration, and allows the payload to be separated into distinct components (or "payload items"), for which the qualification process is performed separately (e.g., one qualification for the high source strength density components/materials and another qualification for the low source strength density materials). As an example, for radiologically non-homogenous materials such as contaminated soil with hot "chunks", the components would be the soil and the hotter particles.

Crud/contamination (or any similar finely distributed powder or granular) sources must be treated separately if there is a potential for redistribution (i.e., if the source is not chemically or physically bound to its substrate or bulk material). In such cases, the crud (or powder) source component must be qualified using only the γ/sec limits.

Gamma sources below 0.3 MeV may be neglected. Any sources with gamma energies above 3.5 MeV are not qualified at this time. Table 7-1 has two special rows for the common radioactive nuclides, ^{60}Co and ^{137}Cs; and so their fractions may be calculated directly without breaking them down into their separate energy lines.

Pure beta emitters (e.g., ^{3}H, ^{32}P, ^{35}S, ^{90}Sr, ^{90}Y) can affect package exterior gamma dose rates due to bremsstrahlung radiation. These emitters must therefore be qualified by converting the beta source strength into an equivalent bremsstrahlung (gamma) source and entering the equivalent gammas like any other gamma source line in the sum-of-fractions. Beta sources with maximum beta energies below 0.3 MeV or payload source strengths less than 2E+12 β/sec may be neglected. Beta sources with peak beta energies over 3.5 MeV are not qualified at this time. Beta source strength from isotopes with significant gamma source strength may also be neglected. The method for converting betas is presented in the procedure below and the methodology is discussed in Chapter 5 of the SAR.

Payload items with densities between 0.0 and 9.0 g/cc are within the range of validity for Table 7-1 γ/sec·g limits. Most materials fall within this range, with the exception of lead and some exotic metals. Do not consider liner, or other secondary container, materials when calculating density. Densities are for the basic material, and should not include voids. Radioactive payload items with densities above 9.0 g/cc must be qualified using the γ/sec limits alone.

In summary, all sources must be accounted for using the sum-of-fractions method described in the following procedure. The only sources which may be considered insignificant (and not included in the sum-of-fractions) are:

- Gammas with energies below 0.3 MeV,
- All pure beta emitters with peak energies below 0.3 MeV,
- Pure beta emitters with peak energies above 0.3 MeV when the combined source of all such betas is under $2x10^{12}$ β/sec.
- Beta emissions from gamma-emitting isotopes.

Table 7-1 - Payload Source Strength and Source Strength Density Limits

Energy (MeV)	General Sources		Discrete Sources (shored at centroid)*		
	Source γ/sec	Source Density γ/sec·g	Source γ/sec	Source Density γ/sec·g	
				$2.5\ ft^3$	55 gal
	❶	❷	❸	❹	❺
3.50	9.611E+09	4.434E+05	2.504E+11	2.957E+06	1.563E+06
2.75	1.285E+10	6.515E+05	3.293E+11	4.301E+06	2.281E+06
2.25	1.823E+10	1.065E+06	4.432E+11	6.800E+06	3.634E+06
1.83	3.040E+10	2.061E+06	6.404E+11	1.279E+07	6.869E+06
1.50	6.111E+10	4.938E+06	8.971E+11	2.920E+07	1.592E+07
1.17	2.142E+11	1.640E+07	1.528E+12	8.418E+07	6.173E+07
0.90	8.635E+11	5.539E+07	2.747E+12	2.796E+08	1.919E+08
0.70	2.131E+12	1.887E+08	5.088E+12	9.566E+08	6.366E+08
0.50	7.075E+12	1.298E+09	1.151E+13	6.529E+09	4.185E+09
Co-60	1.393E+11	1.182E+07	1.294E+12	6.169E+07	4.074E+07
Cs-137	2.580E+12	2.556E+08	5.768E+12	1.281E+09	8.536E+08

**For discrete source limits, use columns ❸ and ❹ when the payload object meets the $2.5\ ft^3$ size criteria, or columns ❸ and ❺ when it meets the 55 gallon size criteria. When the size meets neither criteria use columns ❶ and ❷.*

Qualification Procedure

The Payload Qualification Flowchart (Figure 7-1) provides a graphical overview of the qualification process. The procedure below provides more detailed step-wise instructions.

1. Determine the number of types of material (payload items) in the payload. For each item, determine the configuration (i.e., general or discrete), isotopic source strength (in γ/sec), isotopic source strength density (in γ/sec·g for the hottest portion of the payload item), dimensions, volume, mass, and maximum mass density. Determine the payload totals for each parameter.

2. For payloads that include pure beta emitters with maximum beta energies > 0.3 MeV and $\sum S_\beta \geq$ 2E+12 β/sec, convert each beta source to an equivalent gamma source for each payload item.

   - Confirm that no isotope peak beta energies are > 3.5 MeV; materials with beta energies > 3.5 MeV are unacceptable.
   - The equivalent gamma source for each payload item, S_γ, equals 3.5E-04 S_β Z_w $E_{\beta avg}$ in gammas per sec; where:
     S_β is the beta source strength in β/sec ,
     Z_w is the weighted average Z of the beta-absorbing material; for a single material absorber, use the Z of the material, for compounds or mixtures, use a weighted average Z_w:

$$Z_W = \sum_{i=1}^{n} \left(\frac{m_i}{m_{total}} \cdot Z_i \right)$$

     Z_w is determined, as described above, for both the waste payload and the wall of the secondary container (liner) that the waste resides in, the higher of the two Z_w values is used, and
     $E_{\beta avg}$ is the <u>average</u> energy of the beta in MeV.

   - The resulting equivalent gamma source has strength S_γ at an energy of $E_{\beta max}$, the <u>maximum</u> beta energy.
   - Include the equivalent gamma source along with the other gamma source(s) determined in Step 3.
   - Equivalent gamma energies must be rounded up to the next higher energy level listed in Table 7-1.

3. For each gamma energy of each payload item (ignoring gamma energies below 0.3 MeV), calculate the total γ/sec for the payload item <u>and</u> the γ/sec·g for the hottest (highest source strength density) portion of the item.

   - ^{60}Co and ^{137}Cs may be treated like single "energies" since they have their own limits in Table 7-1.
   - Gamma energies must be rounded up to the next higher energy level listed in Table 7-1.

- If any gammas have energies above 3.5 MeV, the material is unacceptable for transport in the package.
- For payloads with a large number of gammas, the gammas may be grouped into the energy groups in Table 7-1and the total gamma sources can be determined for each group. The energies listed in Table 7-1are the maximum energies for the groups.
- Calculations of γ/sec·g should not include the mass of liners or other secondary containers.

4. For each payload item, select the two appropriate limit columns (❶ through ❺) in Table 7-1: one each for γ/sec and γ/sec·g. Base the γ/sec on the total γ/sec for the item, and the γ/sec·g on the highest source strength density ("hottest") portions of the item.

   - Confirm that the density of each payload item is less than 9.0 g/cm$^{3.}$ Items with higher densities can only be qualified using the γ/sec limits because the γ/sec·g limits are not valid for $\rho \geq 9.0$ g/cm^3.
   - For "discrete" sources, confirm that the sources meet the shoring requirement and the volume and the physical dimension specifications listed in the beginning of this Attachment.
   - Crud/contamination (or powder) payload items can only be qualified using the γ/sec limits (Table 7-1, column ❶ or ❸).

5. For each energy, calculate the γ/sec and γ/sec·g fractions (i.e., payload item source/limit fraction). Select the <u>smallest</u> of each pair of fractions at each energy and add the resulting fraction to the running sum of fractions.

6. Repeat Steps 4-5 for each payload item, adding the fractions to the running sum.

7. If the sum-of-fractions is less than 0.95, the payload's radiological source is acceptable.

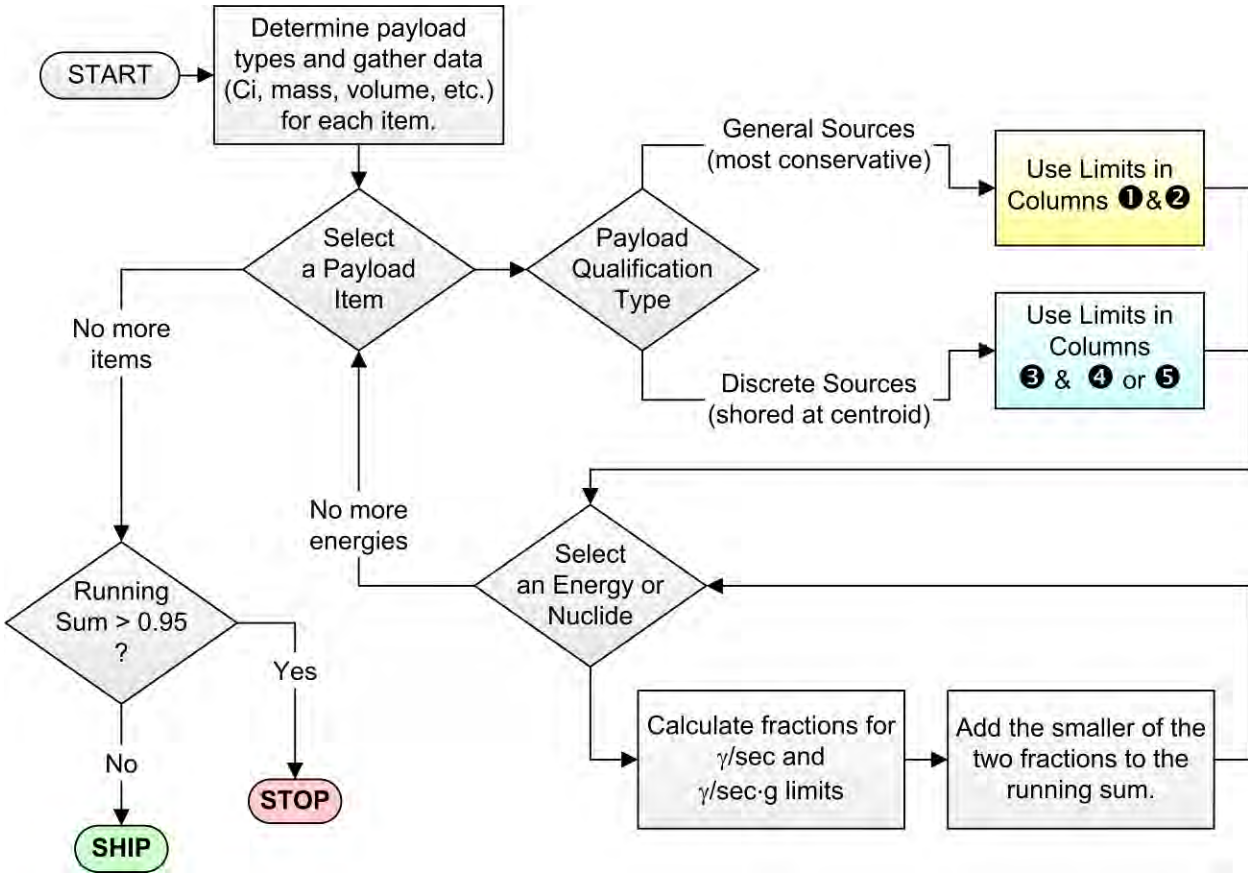
START
Determine payload types and gather data (Ci, mass, volume, etc.) for each item.
Select a Payload Item
Payload Qualification Type
General Sources (most conservative)
Use Limits in Columns ❶&❷
Discrete Sources (shored at centroid)
Use Limits in Columns ❸ & ❹ or ❺
No more items
No more energies
Select an Energy or Nuclide
Running Sum > 0.95 ?
Yes
No
STOP
SHIP
Calculate fractions for γ/sec and γ/sec·g limits
Add the smaller of the two fractions to the running sum.

Figure 7-1 – Payload Qualification Flow Chart

Example 1 - Cs-137 Source Capsule

Problem: Determine the acceptability of a 50 Ci ^{137}Cs source to be centrally shored. The source is a metal capsule 2 cm in diameter by 10 cm long, and the Cs source pellet weighs 50 g.

Step 1: Characterize Source

Given in the problem statement.

Step 2: Convert Beta Source to Equivalent Gamma Source

Not applicable (Cs-137 is not a pure beta emitter).

Step 3: Calculate Gamma Source Strengths and Source Strength Densities

The qualification Table has specific limits for ^{137}Cs, so it is not necessary to do the qualification by energy line. The source's Ci source strength must be converted to γ/sec and γ/sec·g in order to calculate the source/limit fractions. ^{137}Cs produces 0.85 gammas per decay with an energy of 0.66 MeV. The total source strength is

$$3.7\times10^{10}\,\frac{d}{Ci}\times\frac{0.85\gamma}{d}\times 50Ci = 1.57\times10^{12}\,\frac{\gamma}{\sec},$$

and, dividing by 50 g, the total source strength density is 3.14E10 γ/sec·g.

Step 4: Select the Limits

Since this payload is to be shipped in a shored configuration, the payload is a "discrete" type payload. The size fits within the defined envelope for the 2.5 ft^3 payload, therefore the column ❸ and ❹ limits apply for γ/sec and γ/sec·g, respectively.

Steps 5-7 Sum the Fractions

For this example, there is only one fraction to calculate[3].

Line	Payload Item	Type	Shape (Discrete Only)	Energy (MeV),or Nuclide	Payload Source Term		Limits				Frac ions, F		F_{min}
					γ/sec	γ/sec·g	Energy	❸ γ/sec		❹ γ/sec·g	γ/sec	γ/sec·g	
1	Source	Discrete	2.5 ft3	Cs-137	1.57E+12	3.15E+10	Cs-137	❸ 5.77E+12		❹ 1.28E+09	2.73E-01	2.46E+01	2.73E-01
												Sum:	2.73E-01

Since the sum is less than 0.95, the source is an acceptable payload.

[3] Always perform calculations with the full precision for the limits shown in Table . In these examples, full precision data was used, but the number of digits is reduced for presentation purposes.

Example 2 – Solidified Process Waste

Problem: Determine the acceptability of a 100 ft^3 secondary container containing solidified process waste. The activity is uniformly distributed. The measured weight of the filled container is 13,100 lbs, and the weight of the empty container is 1,100 lbs. The isotopic activity, determined by analysis of samples of the waste, is:

5 Ci of ^{60}Co, 10 Ci of ^{137}Cs, 50 Ci of ^{55}Fe, 4 Ci of ^{54}Mn, and 20 Ci of ^{90}Sr

Step 1: Characterize Source

Given in the problem statement.

Step 2: Convert Beta Source to Equivalent Gamma Source

^{90}Sr emits beta radiation through its own decay, plus the decay of its short-lived daughter product, ^{90}Y. So the beta production rate is 20 Ci * 3.7E+10 d/Ci *2 = 1.5E+12 β/sec. Since this is below the threshold of 2E+12 β/sec, the beta production is not significant and can be disregarded.

Step 3: Calculate Gamma Source Strengths and Source Strength Densities

The qualification Table has specific limits for ^{60}Co and ^{137}Cs, but it will be necessary to do the qualification by energy line for the remaining nuclides. After converting the Ci data to gamma energy lines for the remaining nuclides (neglecting any gamma energy lines < 0.3 MeV), the following source data are to be used for qualification. The γ/sec·g source strength densities are based on 12,000 lbs, the actual weight of the radioactive material. The mass density is assumed to be uniform for the payload.

Energy (MeV),or Nuclide	Payload Source Term	
	γ/sec	γ/sec·g
Co-60	3.70E+11	6.80E+04
Cs-137	3.15E+11	5.78E+04
0.8348	1.48E+11	2.72E+04

Step 4: Select the Limits

Since this payload does not meet the definition of either of the two discrete shored configurations (2.5 ft^3 or 55 gal), it is a "general" type payload. The limits in columns ❶ and ❷ apply for γ/sec and γ/sec·g, respectively.

Steps 5-7 Sum the Fractions

For this example, there are three lines: a ^{60}Co line, ^{137}Cs line, and one energy line representing ^{54}Mn (^{55}Fe and ^{90}Sr are disregarded because ^{55}Fe gammas are below 0.3 MeV, and the ^{90}Sr betas are below 2E+12 β/sec).

Line	Payload Item	Type	Shape (Discrete Only)	Energy (MeV),or Nuclide	Payload Source Term		Limits					Fractions, F		F_{min}
					γ/sec	γ/sec□g	Energy	❶	γ/sec	❷	γ/sec□g	γ/sec	γ/sec□g	
1	Solidified Waste Cont.	General		Co-60	3.70E+11	6.80E+04	Co-60	❶	1.39E+11	❷	1.18E+07	2.66E+00	5.75E-03	5.75E-03
2	Solidified Waste Cont.	General		Cs-137	3.15E+11	5.78E+04	Cs-137	❶	2.58E+12	❷	2.56E+08	1.22E-01	2.26E-04	2 26E-04
3	Solidified Waste Cont.	General		0.8348	1.48E+11	2.72E+04	0.9	❶	8.63E+11	❷	5.54E+07	1.71E-01	4.91E-04	4 91E-04
													Sum:	6.47E-03

Since the sum is less than 0.95, the container is an acceptable payload.

Example 3 – Dewatered Resin Liner

Problem: Determine the acceptability of a 100 ft^3 steel secondary container containing dewatered resin. The activity is uniformly distributed. The measured weight of the filled container is 13,100 lbs; the weight of the empty container is 1,100 lbs. The isotopic activity, determined by analysis of samples of the waste, is: 5 Ci of ^{60}Co, 10 Ci of ^{137}Cs, 50 Ci of ^{55}Fe, 4 Ci of ^{54}Mn, and 30 Ci of ^{90}Sr. Also included is a 100 gram piece of activated metal, not shored, with an activity of 0.5 Ci of ^{60}Co. The activated metal is steel with a density of 8 g/cm^3.

This differs from Example 2 in that there is more ^{90}Sr, and there is the additional piece of activated metal.

Step 1: Characterize Source

Given in the problem statement.

Step 2: Convert Beta Source to Equivalent Gamma Source

^{90}Sr emits beta radiation through its own decay, plus the decay of its short-lived daughter product, ^{90}Y. So the total beta production rate is 30 Ci * 3.7E+10 d/Ci * 2 = 2.22E+12 betas/sec. Since this is above the threshold of 2E+12 betas/sec, the beta production must be considered. Using the procedure to convert beta into equivalent gamma radiation described in Attachment 1, the $^{90}Sr/^{90}Y$ betas[4] will be treated as follows:

E_{maxSr} = 0.54 MeV, E_{avgSr} = 0.19 MeV

E_{maxY} = 2.27 MeV, E_{avgY} = 0.93 MeV

Z_{Resin} = 5.6, Z_{Steel} = 26

Z_w= 26 (the higher of the resin Z and the liner wall Z)

$S_{\gamma Sr}$ =(1.11E+12)(3.5E-04)(26)(0.19)= 1.92E+08 γ/s @ 0.54 MeV

$S_{\gamma Y}$ =(1.11E+12)(3.5E-04)(26)(0.93)= 9.39E+09 γ/s @ 2.27 MeV

Step 3: Calculate Gamma Source Strengths and Source Strength Densities

This payload must be broken into two payload items, due to the physical and radiological differences between the resins and the activated metal.

[4] Cember, H., "Introduction to Health Physics," Pergamon Press, 2nd Ed.

Resin Payload Item

Like Example 2, the following source data are to be used for qualification of the gamma emitters. The mass density is assumed to be uniform for the resin portion of the payload.

Energy (MeV),or Nuclide	Payload Source Term	
	γ/sec	γ/sec·g
Co-60	3.70E+11	6.80E+04
Cs-137	3.15E+11	5.78E+04
0.8348	1.48E+11	2.72E+04

Activated Metal Payload Item

^{60}Co emits two gammas per disintegration, therefore the total source strength for the activated metal is (0.5 Ci)(2 γ/d)(3.7E+10 d/sec-Ci) = 3.7E+10 γ/sec. Dividing by the mass of 100 g, the source strength density is 3.7E+08 γ/sec. The mass density is assumed to be uniform for the 100 gram piece of metal.

Step 4: Select the Limits

Resin Payload Item - Since this payload item does not meet the definitions of either of the two discrete shored configurations (2.5 ft^3 or 55 gal), it is a "general" type payload. The limits in columns ❶ and ❷ apply for γ/sec and γ/sec·g, respectively.

Activated Metal Payload Item – This payload item is small and fits within the defined envelope for the 2.5 ft^3 payload, however it is not shored, and so the activated metal is also a "general" type payload item. Columns ❶ and ❷ apply for the γ/sec and γ/sec·g limits, respectively.

Steps 5-7 Sum the Fractions

For this example, there are six lines: 1-3 are for the resin gamma emitters, 4-5 are for the bremsstrahlung gammas produced by ^{90}Sr and ^{90}Y, and one line for the activated metal ^{60}Co.

Line	Payload Item	Type	Shape (Discrete Only)	Energy (MeV),or Nuclide	Payload Source Term		Limits					Fractions, F		F_{min}
					γ/sec	γ/sec·g	Energy	❶ γ/sec		❷ γ/sec·g		γ/sec	γ/sec·g	
1	Resin	General		Co-60	3.70E+11	6.80E+04	Co-60	❶	1.39E+11	❷	1.18E+07	2.66E+00	5.75E-03	5.75E-03
2	Resin	General		Cs-137	3.15E+11	5.78E+04	Cs-137	❶	2.58E+12	❷	2.56E+08	1.22E-01	2.26E-04	2 26E-04
3	Resin	General		0.8348	1.48E+11	2.72E+04	0.9	❶	8.63E+11	❷	5.54E+07	1.71E-01	4.91E-04	4 91E-04
4	Resin (betas)	General		0.54	1 92E+08	3.53E+01	0.7	❶	2.13E+12	❷	1.89E+08	9.01E-05	1.87E-07	1 87E-07
5	Resin (betas)	General		2.27	9 39E+09	1.73E+03	2.75	❶	1.29E+10	❷	6.51E+05	7.30E-01	2.65E-03	2.65E-03
6	Metal	General		Co-60	3.70E+10	3.70E+08	Co-60	❶	1.39E+11	❷	1.18E+07	2.66E-01	3.13E+01	2.66E-01
													Sum:	2.75E-01

Since the sum is less than 0.95, the container is an acceptable payload.

Example 4 – Activated Waste with Non-Fixed Contamination

Problem: Determine the acceptability of a 100 ft^3 steel secondary container containing activated metal. The measured weight of the filled container is 7,100 lbs; the weight of the empty container is 1,100 lbs. The metal is composed of mildly activated steel, with non-fixed surface contamination. The contaminated surface area is estimated to be 500 ft^2. There is one small piece of activated steel with a significantly higher activity. Determine whether this smaller item can be included in the shipment, and whether it needs to be shored. The isotopic activities, determined by analysis of samples of the waste, are as follows:

- Most of the steel has similar radiological properties. Based on an analysis of the highest-activity sample, the constituents are: 20 Ci of ^{58}Co, 30 Ci of ^{60}Co, and 20 Ci of ^{54}Mn.
- The small activated metal item has a mass of 100 g, dimensions of 1" x 1" x 24", with an activity of 6 Ci of ^{60}Co.
- The non-fixed crud contamination level, based on the highest-activity sample, is 50,000 dpm, which has been determined to be 50% ^{55}Fe, 30% ^{137}Cs, and 20% ^{60}Co. The contaminated surface area is 500 ft^2.

Step 1: Characterize Source

Given in the problem statement.

Step 2: Convert Beta Source to Equivalent Gamma Source

Not applicable since the beta source is less than 2E+12 β/sec.

Step 3: Calculate Gamma Source Strengths and Source Strength Densities

100g Activated Metal Payload Item

^{60}Co emits two gammas per disintegration, therefore the total source strength for the small activated metal item is (6 Ci)(2 γ/d)(3.7E+10 d/sec-Ci) = 4.44E+11 γ/sec. Dividing by the mass of 100 g, the source strength density is 4.44E+09 γ/sec. The mass density is assumed to be uniform for the small activated metal item.

Energy (MeV),or Nuclide	Payload Source Term	
	γ/sec	γ/sec-g
Co-60	4.44E+11	4.44E+09

Remaining Activated Metal Payload Item

^{60}Co emits two gammas per disintegration, therefore the total ^{60}Co source strength for the activated metal is (30 Ci)(2 γ/d)(3.7E+10 d/sec-Ci) = 2.22E+12 γ/sec. The remaining nuclides, ^{58}Co and ^{54}Mn, were converted to individual energy lines[5] (E<0.3 MeV were neglected). Sources were divided by 2.72E+06 g (i.e., 6,000 lb) to obtain the γ/sec·g. The mass density of the metal is assumed to be uniform. The resulting sources are:

Energy (MeV),or Nuclide	Payload Source Term	
	γ/sec	γ/sec·g
Co-60	2.22E+12	8.16E+05
0.511	2.21E+11	8.12E+04
0.8108	7.36E+11	2.70E+05
0.8348	7.40E+11	2.72E+05
0.8639	5.45E+09	2.00E+03
1.6747	3.97E+09	1.46E+03

Crud Payload Item

50,000 dpm is equivalent to 2.25E-08 Ci per 100 cm^2. The total source strength is therefore (2.25E-08 Ci/100cm^2) (500 ft^2)(929 cm^2/ft^2) = 1.05E-04 Ci. The nuclide breakdown is therefore: 5.23E-05 Ci of ^{55}Fe, 3.14E-05 Ci of ^{137}Cs, and 2.09E-05 Ci of ^{60}Co. ^{55}Fe can be neglected since it does not emit any gammas > 0.3 MeV. We can only use the γ/sec limit for qualification. The source inputs are therefore:

Energy (MeV),or Nuclide	Payload Source Term	
	γ/sec	γ/sec·g
Co-60	1.55E+06	
Cs-137	9.88E+05	

Step 4: Select the Limits

The 100g activated item would meet the size criteria for the 55-gallon discrete shored configuration if both the container were shored and the item was shored within the container, in which case its limits would be columns ❸ and ❺ for γ/sec and γ/sec·g, respectively. Otherwise, since it would be unshored, the limits in columns ❶ and ❷ would apply for γ/sec and γ/sec·g, respectively.

The remaining activated metal does not meet the definitions of either of the two discrete shored configurations (2.5 ft^3 or 55 gal), so it is a "general" type payload item. The limits in columns ❶ and ❷ apply for γ/sec and γ/sec·g, respectively.

[5] MicroShield, Version 8.01, Grove Engineering.

The crud is free to move within the cavity and is therefore a "general" type payload item. Also, as discussed in the first section of this Attachment, crud must be qualified using the γ/sec limit. Thus, the limit in column ❶,in γ/sec, applies for the crud.

Steps 5-7 Sum the Fractions

First we will try qualifying the payload without shoring the small activated item. Note that it is not acceptable to average the activated metal together with the small 100 g item.

Line	Payload Item	Type	Shape (Discrete Only)	Energy (MeV),or Nuclide	Payload Source Term		Limits					Fractions, F		F_{min}
					γ/sec	γ/sec·g	Energy	γ/sec		γ/sec·g		γ/sec	γ/sec·g	
1	100g activated item	General	55 gal	Co-60	4.44E+11	4.44E+09	Co-60	❶	1.39E+11	❷	1.18E+07	3.19E+00	3.76E+02	3.19E+00
2	Remaining metal	General		Co-60	2.22E+12	8.16E+05	Co-60	❶	1.39E+11	❷	1.18E+07	1.59E+01	6.90E-02	6.90E-02
3	Remaining metal	General		0 511	2.21E+11	8.12E+04	0.7	❶	2.13E+12	❷	1.89E+08	1.04E-01	4.30E-04	4.30E-04
4	Remaining metal	General		0.8108	7.36E+11	2.70E+05	0.9	❶	8.63E+11	❷	5.54E+07	8.52E-01	4.88E-03	4.88E-03
5	Remaining metal	General		0.8348	7.40E+11	2.72E+05	0.9	❶	8.63E+11	❷	5.54E+07	8.57E-01	4.91E-03	4.91E-03
6	Remaining metal	General		0.8639	5.45E+09	2.00E+03	0.9	❶	8.63E+11	❷	5.54E+07	6.31E-03	3.61E-05	3.61E-05
7	Remaining metal	General		1.6747	3.97E+09	1.46E+03	1.83	❶	3.04E+10	❷	2.06E+06	1.31E-01	7.08E-04	7.08E-04
8	Crud	General		Co-60	1.55E+06		Co-60	❶	1.39E+11	❷	1.18E+07	1.11E-05		1.11E-05
9	Crud	General		Cs-137	9.88E+05		Cs-137	❶	2.58E+12	❷	2.56E+08	3.83E-07		3.83E-07
													Sum:	3.27E+00

This approach does not pass. Since the discrete shored payload items have higher limits, we can try to see if shoring the 100g item will pass.

Line	Payload Item	Type	Shape (Discrete Only)	Energy (MeV),or Nuclide	Payload Source Term		Limits					Fractions, F		F_{min}
					γ/sec	γ/sec·g	Energy	γ/sec		γ/sec·g		γ/sec	γ/sec·g	
1	100g activated item	Discrete	55 gal	Co-60	4.44E+11	4.44E+09	Co-60	❸	1.29E+12	❺	4.07E+07	3.43E-01	1.09E+02	3.43E-01
2	Remaining metal	General		Co-60	2.22E+12	8.16E+05	Co-60	❶	1.39E+11	❷	1.18E+07	1.59E+01	6.90E-02	6.90E-02
3	Remaining metal	General		0 511	2.21E+11	8.12E+04	0.7	❶	2.13E+12	❷	1.89E+08	1.04E-01	4.30E-04	4.30E-04
4	Remaining metal	General		0.8108	7.36E+11	2.70E+05	0.9	❶	8.63E+11	❷	5.54E+07	8.52E-01	4.88E-03	4.88E-03
5	Remaining metal	General		0.8348	7.40E+11	2.72E+05	0.9	❶	8.63E+11	❷	5.54E+07	8.57E-01	4.91E-03	4.91E-03
6	Remaining metal	General		0.8639	5.45E+09	2.00E+03	0.9	❶	8.63E+11	❷	5.54E+07	6.31E-03	3.61E-05	3.61E-05
7	Remaining metal	General		1.6747	3.97E+09	1.46E+03	1.83	❶	3.04E+10	❷	2.06E+06	1.31E-01	7.08E-04	7.08E-04
8	Crud	General		Co-60	1.55E+06		Co-60	❶	1.39E+11	❷	1.18E+07	1.11E-05		1.11E-05
9	Crud	General		Cs-137	9.88E+05		Cs-137	❶	2.58E+12	❷	2.56E+08	3.83E-07		3.83E-07
													Sum:	4.23E-01

Since the sum is less than 0.95, the container is an acceptable payload if the container and 100 g item are shored such that the 100g item is located at the centroid of the cask cavity.

Example 5 – Contaminated Soil

Problem: Determine the acceptability of a 100 ft^3 steel secondary container containing a contaminated soil mixture. The activity is not uniformly distributed. The measured weight of the filled container is 10,100 lbs; the weight of the empty container is 1,100 lbs. 5% of the payload mass is made up of small bits of grout used to immobilize contamination. The size of the grout chunks ranges from 0.1 cm to 10 cm. The grout contains ^{137}Cs at a maximum concentration of 350 Ci/ft^3. The remaining 95% of the material is soil with a activity of 10 Ci/ft^3 of ^{137}Cs. The density of the soil and grout are both 100 lb/ft^3. Activities were determined by analysis of samples of the most active representative waste.

Step 1: Characterize Source

Given in the problem statement.

Step 2: Convert Beta Source to Equivalent Gamma Source

Not applicable (Cs-137 is not a pure beta emitter).

Step 3: Calculate Gamma Source Strengths and Source Strength Densities

We will evaluate the payload two ways: one treating the entire payload as a single item with a bounding source strength (γ/sec) and source strength density (γ/sec·g), and the second assuming we will treat the payload as two separate items: grout and soil.

If there is a potential for the contamination to redistribute, then it would be appropriate to qualify the source using only the γ/sec limits. For this example, the grout physically prevents its contamination from redistribution, and for simplicity we assume that the soil, which has a much lower source strength density, also physically binds its contaminants. For both payload items, we will therefore perform the qualification using both source strength (γ/sec) and source strength density (γ/sec·g). Note that this example does account for the possibility that the grout will redistribute (or concentrate) itself within the soil, since the single payload approach will use the higher source strength density (γ/sec·g) of the grout in the qualification.

Grout Payload Item

The grout gamma source strength is (350 Ci/ft^3)(1 ft^3/100 lb)(9,000 lb*0.05) (3.7E+10 d/sec-Ci)(0.85 γ/d) = 4.95E+13 γ/sec. Dividing by the mass (450 lb, or 2.04E+05 g), the source strength density would be 2.43E+08 γ/sec·g.

Payload Source Term	
γ/sec	γ/sec·g
4.95E+13	2.43E+08

Soil Payload Item

The soil gamma source strength is (10 i/ft^3)(1 ft^3/100 lb)(9,000 lb*0.95)(3.7E+10 d/sec-Ci)(0.85 γ/d) = 2.69E+13 γ/sec. Dividing by the mass (8550 lb, or 3.88E+06 g), the source strength density would be 6.93E+06 γ/sec·g.

Energy (MeV),or Nuclide	Payload Source Term	
	γ/sec	γ/sec·g
Cs-137	2.69E+13	6.93E+06

Combined Grout/Soil Payload Item

If the payload is treated as a single item, the γ/sec is set equal to the sum of the γ/sec for both the grout and soil components. The γ/sec·g is set equal to that of the "hottest" component (i.e., the grout). Thus, the gamma source strength would be 5.66E+13 γ/sec (4.95E+13 + 2.69E+13). The γ/sec·g equals the 2.43E+08 value that applies for the grout.

Payload Source Term	
γ/sec	γ/sec·g
7.64E+13	2.43E+08

Step 4: Select the Limits

Since none of these payload items meets the definition of either of the two discrete shored configurations (2.5 ft^3 or 55 gal), they are "general" type payload items. The limits in columns ❶ and ❷ apply for γ/sec and γ/sec·g, respectively.

Steps 5-7 Sum the Fractions

As a first try, we attempt to qualify the payload as being two components: the grout and soil.

Line	Payload Item	Type	Shape (Discrete Only)	Energy (MeV),or Nuclide	Payload Source Term		Limits					Fractions, F		F_{min}
					γ/sec	γ/sec·g	Energy	❶	γ/sec	❷	γ/sec·g	γ/sec	γ/sec·g	
1	Grout	General		Cs-137	4.95E+13	2.43E+08	Cs-137	❶	2.58E+12	❷	2.56E+08	1.92E+01	9.50E-01	9.50E-01
2	Soil	General		Cs-137	2.69E+13	6.93E+06	Cs-137	❶	2.58E+12	❷	2.56E+08	1.04E+01	2.71E-02	2.71E-02
													Sum:	9.77E-01

Since the sum is greater than 0.95, the container is not an acceptable payload.

It is acceptable, however, to treat the payload as a single (combined) item, with a γ/sec equal to the sum of the component (grout and soil) γ/sec values, and a γ/sec·g equal to that of the "hottest" component (i.e., the grout).

Line	Payload Item	Type	Shape (Discrete Only)	Energy (MeV),or Nuclide	Payload Source Term		Limits				Fractions, F		F_{min}
					γ/sec	γ/sec·g	Energy	γ/sec		γ/sec·g	γ/sec	γ/sec·g	
1	All-grout	General		Cs-137	7.64E+13	2.43E+08	Cs-137	❶	2.58E+12	❷ 2.56E+08	2.96E+01	9.50E-01	9.50E-01
												Sum:	9.50E-01

Since the sum is less than 0.95, the container is an acceptable payload.

This example illustrates that there is no benefit from dividing a payload into multiple payload items if all of the items qualify under the γ/sec·g limit. If the payload is divided, one of the (γ/sec·g) fractions will be that which applies for the grout (i.e., 0.950). If the single payload approach is used, the γ/sec·g value is set to that which applies for the "hottest" item (the grout), so the total fraction for the entire payload would be 0.950. Separating small, high source strength density items from the overall payload only helps if those small (low mass) items are qualified under the γ/sec limit, and not the γ/sec·g limit.

Attachment 2
Determination of Hydrogen Concentration

1. Determine the radionuclide concentration in the contents.

   For any package containing materials with radioactivity concentration not exceeding that for LSA, ensure the shipment occurs within 10 days of preparation, or within 10 days of venting the secondary container.

   For packages which satisfy the previous conditions, go to step 11, otherwise continue with step 2.

2. Determine the secondary package(s) void volume and the cask cavity void volume.

3. Identify the secondary container(s) vent path, if applicable

4. Determine the quantity of hydrogenous contents

5. Determine the G value of the hydrogenous contents per NUREG/CR-6673[6], Section 3.

6. Determine the energy deposition rate in the hydrogenous contents

7. Determine the hydrogen generation rate per NUREG/CR-6673, Section 4.2

8. Determine the effective hydrogen transport rate due to diffusion for the vent path; see NUREG/CR-6673, Section 4.1

9. Determine the shipping time to reach a hydrogen concentration of 5% in the package; see NUREG/CR-6673, Section 4.2.2.1 and Appendix F, Example #4.

10. If the time to reach 5% concentration is more than double the expected shipping time, the shipment meets the hydrogen concentration requirement.

11. Authorize the shipment

[6] B. L. Anderson et al. *Hydrogen Generation in TRU Waste Transportation Packages* , NUREG/CR-6673, Lawrence Livermore National Laboratory, Livermore, CA, February 2000

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8.0 Acceptance Tests and Maintenance Program

Acceptance tests for Configurations 1 and 2 have different weld examination and leak tests than Configuration 3. Maintenance is the same for all configurations. Any reference to drawings, either in general or by specific number, means the drawings listed in the CoC.

8.1 ACCEPTANCE TESTS – CONFIGURATIONS 1 AND 2 (CASKS FABRICATED BEFORE APRIL 1, 1999)

Prior to the first use of the 8-120B package fabricated to Configuration 1 or 2, the following tests and evaluations will be performed.

8.1.1 VISUAL EXAMINATION

The package will be examined visually for any adverse conditions in materials or fabrication. Welds shall be examined for compliance to the drawings. Weld integrity shall be verified by visual examination and magnetic particle or dye penetrant. NDE examinations shall be performed by an ASME Certified inspector. Acceptance criteria for NDE shall be according to ASME Code Section III, Div. 1-Section NB5342 or NB5352 as applicable.

8.1.2 STRUCTURAL TESTS

No structural testing is required.

8.1.3 LEAK TESTS

This test shall be performed prior to acceptance and operation of a newly fabricated package in accordance with ASTM E-427 using a leak detector capable of detecting the applicable leak rates specified in Figures 4-4 and 4-7 in Chapter 4. Calibration of the leak detector shall be performed using a leak rate standard traceable to NIST. The standard's setting shall correspond to the approved leak rates specified in Figures 4-4 and 4-7 in Chapter 4.

All four containment boundary penetrations must be tested.

- The volume above the vent port Stat-O-Seal
- The volume between the drain line plug and interior of the cask
- The annulus between the o-ring seals of the primary lid
- The annulus between the o-ring seals of the secondary lid

All four of these volumes must be evacuated to a minimum vacuum of 20" Hg, and then be pressurized to a minimum pressure of 25 psig with pure dichlorodifluoromethane (R-12) or 1,1,1,2 – tetrafluoroethane (R-134a). Use the detector probe to "sniff" the following areas:

- The vent port penetration on the underside of the primary lid
- Around the outer plug of the drain line
- Interior side of the inner o-ring for the primary lid

- Interior side of the inner o-ring for the secondary lid

Leak detection shall be in accordance with the specifications of ASTM E-427.

Any condition, which results in leakage in excess of the applicable values specified in Figures 4-3 and 4-6 in Chapter 4 shall be corrected.

8.1.4 COMPONENT TESTS

Gaskets and seals will be procured and examined in accordance with the Energy*Solutions* Quality Assurance Program.

8.1.5 TEST FOR SHIELDING INTEGRITY

Shielding integrity of the package will be verified by gamma scan or gamma probe methods to assure the package is free of significant voids in the poured lead shield annulus. All gamma scanning will be performed on a 4-inch square or less grid system. The acceptance criteria will be that voids resulting in shield loss in excess of 10 % of the normal lead thickness in the direction measured shall not be acceptable. Remedy for an unacceptable gamma scan include actions such as controlled re-heating of the cask body to melt the lead to remove any voids or streaming paths. This process may be used as long as average metal temperatures are kept below ~800°F. If the remedy could affect more than just the unacceptable area, e.g., re-heating of the cask body, all affected portions will be re-scanned.

8.1.6 THERMAL ACCEPTANCE TESTS

No thermal acceptance testing will be performed on the 8-120B package. Refer to the Thermal Evaluation, Chapter 3.0 of the report.

8.2 ACCEPTANCE TESTS – CONFIGURATION 3 (CASKS FABRICATED AFTER APRIL 1, 1999)

Prior to the first use of an 8-120B package fabricated to Configuration 3, the following tests and evaluations will be performed:

8.2.1 VISUAL INSPECTIONS AND MEASUREMENTS

Throughout the fabrication process, confirmation by visual examination and measurement are required to be performed to verify that the 8-120B packaging dimensionally conforms to the drawing referenced in the current Certificate of Compliance for the 8-120B.

The packaging is also required to be visually examined for any adverse conditions in materials or fabrication that would not allow the packaging to be assembled and operated per Section 7.0 or tested in accordance with the requirements of Section 8.0.

Throughout the fabrication process, the fabricator shall request approval from Energy*Solutions* prior to implementation of any options allowed in the drawing.

8.2.2 WELD EXAMINATIONS

8.2.2.1 All welding of the Containment Boundary identified on drawing C-110-E-0007 will be done in accordance with ASME Code, Section III, Division I, Subsection ND, except as follows:

a. Due to the geometry of the joint configuration, between Item 17 and 18, NDE of the ¾" bevel groove weld and the 1" bevel groove weld may be done by progressive surface examination utilizing the MT method in lieu of RT or UT.

b. Due to the geometry of the joint configuration, between Item 3 and 5A, NDE of the ¾" v groove weld may be done by progressive surface examination utilizing the MT method in lieu of RT or UT.

c. Due to the geometry of the joint configuration, between Item 3 and 4, NDE of the ¾" v groove weld may be done by utilizing the UT + MT methods in lieu of RT.

8.2.2.2 All welding of Non-Containment Boundary items identified on drawing C-110-E-0007 will be done in accordance with ASME Code, Section III, Division I, Subsection NF (Class 3), except as follows:

a. The Root Pass and the Final Pass of the v groove weld between Item 5A, Cask Bottom Plate and Item 5B, Cask Bottom Plate Outer Ring, shall be done in accordance with ASME Code, Section III, Division I, Subsection NF-5230 by magnetic particle examination (MT) with acceptance requirements of ASME Code, Section III, Division I, Subsection NF, Article NF-5340.

b. The Root Pass and the Final Pass of the bevel groove weld between Item 5B, Cask Bottom Plate and Item 1, Outer Cask Shell, shall be done in accordance with ASME Code, Section III, Division I, Subsection NF-5230 by magnetic particle examination (MT) with acceptance requirements of ASME Code, Section III, Division I, Subsection NF, Article NF-5340.

8.2.2.3 Welding on lifting and tiedown lugs identified on drawing C-110-E-0007 will be done in accordance with ASME Code, Section III, Division I, Subsection NF (Class 3) and shall be inspected by magnetic particle examination (MT) with acceptance requirements of ASME Code, Section III, Division I, Subsection ND, Article ND-5340 or NF, Article NF-5340. Inspection shall be before and after 150% load test.

8.2.3 STRUCTURAL AND PRESSURE TESTS

A pressure test of the containment system will be performed as required by 10CFR71.85. As determined in Section 3.4.4, the maximum normal operating pressure for the cask cavity is 35 psig; therefore the minimum test pressure will be 1.5 x 35 = 52.5 psig. The hydrostatic test pressure will be held for a minimum of 10 minutes prior to initiation of any examinations. Following the 10 minute hold time, the cask body, lid and lid/body closure shall be examined for leakage. Any leaks, except from temporary connections, will be remedied and the test and inspection will be repeated. After depressurization and draining, the cask cavity and seal areas

will be visually inspected for cracks and deformation. Any cracks or deformation will be remedied and the test and inspection will be repeated.

8.2.4 LEAKAGE TESTS

8.2.4.1 General requirements

- Testing method – Per ANSI N-14.5 in accordance with ASTM E-427 if using a halogen leak detector or ASTM E-499 if using a helium leak detector.
- Test Sensitivity – the test method must be capable of meeting the appropriate sensitivity requirements specified in Figures 4-4 or 4-7 in Section 4.0. Calibration of the leak detector shall be performed using a leak rate standard traceable to NIST.
- The leak standard's setting shall correspond to the approved leak test rate (see Section 4.0).
- Any condition, which results in leakage in excess of the maximum allowable leak rate specified in Figures 4-3 or 4-6 (depending on the test gas used), shall be corrected and re-tested.

8.2.4.2 Testing of the entire containment boundary will be performed prior to lead pour to allow access to all containment welds. The containment boundary includes: the inner shell, the cask bottom base plate (BOM 5A), the bolting ring, the lids, the O-ring seal plates of both lids, the inner O-ring of both lids, and the vent port cap screw and its seal.

- (Optional) Insert the sealed metal cavity filler canister into the cask cavity. Verify the canister does not obstruct the vent penetration. The metal must be chemically compatible with the cask liner and the test gas.
- Assemble the cask lids per Section 7.1.
- Evacuate the cask cavity to 20" Hg vacuum, minimum (sealed metal cavity filler canister may be used within the cask cavity)
- Pressurize the cask cavity to a minimum pressure of:

1) 25 psig with pure 1,1,1,2 – tetrafluoroethane (R-134a),
or
2) 1 psig with pure helium.

- Check for leakage of the inner shell and base plate components
- Measure the leakage of the inner (containment) O-ring via the test port in each lid.
- Check for leakage at the vent port.

8.2.5 COMPONENT AND MATERIAL TESTS

Energy*Solutions* will apply its USNRC approved 10CFR71 Appendix B Quality Assurance Program, which implements a graded approach to quality based on a component's or material's importance to safety to assure all materials used to fabricate and maintain the 8-120B are

procured with appropriate documentation which meet the appropriate tests and acceptance criteria for packaging materials.

This includes as example:

- ASTM steel material used for shells, lids, bolts, etc. will comply with and meet ASTM manufacturing requirements.
- Containment seals will be made from elastomeric compounds that have been qualified using ES-C-038 (Reference 8.4.2), which includes requirements for hardness, low temperature compatibility, permeability, and temperature-pressure testing. Fabricated seals are suitable for use if the delivered seals are traceable to a batch of material manufactured under the same process as, and having the same chemical composition as, a qualified compound. Acceptance testing for containment seals will include hardness and low temperature compatibility testing on each batch of elastomer, plus dimensional inspections on each seal, all per the acceptance criteria in ES-C-038.
- The impact limiter foam will meet the requirements of ES-M-175 (Reference 8.4.1).

8.2.6 SHIELDING TESTS

Shielding integrity of the package will be verified by gamma scan to assure the package lead layer meets or exceeds the minimum thickness specified on the cask drawing. All gamma scanning will be performed on a 4-inch square or less grid system. The acceptance criteria (maximum dose rate value) will be determined by: Option 1) measurement of the maximum dose rate value using a test block, which has shield layers that replicate the cask geometry per the drawing, using the gamma scan source and reproducing the source/shield/detector geometry that will be used during the scan of the cask, or Option 2) calculation of the maximum dose rate value using detailed modeling software (MCNP or equivalent) incorporating the specific cask dimensions from the drawing and the source/shield/detector geometry applicable to the gamma scan. Any location on the cask which shows a gamma scan dose rate value greater than the maximum dose rate value will be identified as unacceptable. All unacceptable areas will be remedied and re-scanned. Remedy for an unacceptable gamma scan include actions such as controlled re-heating of the cask body to melt the lead to remove any voids or streaming paths. This process may be used as long as average metal temperatures are kept below ~800°F. If the remedy could affect more than just the unacceptable area, e.g., re-heating of the cask body, all affected portions will be re-scanned.

8.2.7 THERMAL TESTS

No thermal acceptance testing will be performed on the 8-120B packaging. Refer to the Thermal Evaluation, Section 3.0 of this report.

8.2.8 MISCELLANEOUS TESTS

No miscellaneous testing will be performed on the 8-120B packaging.

8.3 MAINTENANCE PROGRAM

Energy*Solutions* operates an ongoing preventative maintenance program for all shipping packages. The 8-120B package will be subjected to routine and periodic inspection and tests as outlined in this section and the approved procedure based on these requirements. Defective items are replaced or remedied, including testing, as appropriate.

Examples of inspections performed prior to each use of the cask include:

- Cask Seal Areas: O-rings are inspected for any cracks, tears, cuts, or discontinuities that may prevent the O-ring from sealing properly. O-ring seal seating surfaces are inspected to ensure they are free of scratches, gouges, nicks, cracks, etc. that may prevent the O-ring from sealing properly. Defective items are replaced or remedied, as appropriate and tested in accordance with Section 8.3.2.
- Cask bolts, bolt holes, and washers are inspected for damaged threads, severe rusting or corrosion pitting. Defective items are replaced or remedied, as appropriate.
- Lift Lugs and visible lift lug welds are inspected to verify that no deformation of the lift lug is evident and that no obvious defects are visible. Defective items are replaced or remedied, as appropriate and tested in accordance with Section 8.2.2.5.

8.3.1 STRUCTURAL AND PRESSURE TESTS

No routine or periodic structural or pressure testing will be performed on the 8-120B packaging.

8.3.2 LEAKAGE TESTS

8.3.2.1 Periodic and Maintenance Leak Test.

The 8-120B packaging shall have been leak tested as described below within the preceding 12-month period before actual use for shipment and after maintenance, repair (such as weld repair), or replacement of components of the containment system. Shipments of powdered radioactive materials shall be performed only when the most recent periodic leak test meets the requirements for leaktight status.

The 8-120B packaging seals shall have been replaced within the 12-month period before actual use for shipment.

General requirements

- Testing method – Per ANSI N-14.5 in accordance with ASTM E-427 if using a halogen leak detector or ASTM E-499 if using a helium leak detector.
- Test Sensitivity – the test method must be capable of meeting the appropriate sensitivity requirements specified in Figures 4-4 or 4-7 or 5.0×10^{-8} atm-cm^3/sec for leaktight status. Calibration of the leak detector shall be performed using a leak rate standard traceable to NIST.
- The leak standard's setting shall correspond to the approved leak test rate (see Section 4.0). A maximum leak rate of 1.0×10^{-7} atm-cm^3/sec of air is required leaktight status.

- Any condition, which results in leakage in excess of the appropriate maximum allowable leak rate specified in Figures 4-3, 4-6 or 1.0×10^{-7} atm-cm^3/sec for leaktight status, shall be corrected and re-tested.

Testing of the Lids and Vent

- (Optional) Insert the sealed metal cavity filler canister into the cask cavity. Verify the canister does not obstruct the vent penetration. The metal must be chemically compatible with the cask liner and the test gas.
- Assemble the cask lids per Section 7.1.
- Evacuate the cask cavity to 20" Hg vacuum (minimum) or 90% vacuum for the leak tight test.
- Pressurize the cask cavity to the following pressure:
  1) 25 psig (minimum) with pure 1,1,1,2 – tetrafluoroethane (R-134a),
     or
  2) 1 psig (minimum) with pure helium (or 0 to 1 psig with pure helium for leaktight status).
- Measure the leakage of the inner (containment) O-ring via the test port in each lid.
- Measure the leakage of the vent port.

Testing of the Lids – Optional Method

- Assemble the cask lids per Section 7.1.
- Connect to the O-ring test port on the lid and evacuate the annulus between the cask lid O-rings to 20" Hg vacuum (minimum)
- Pressurize the O-ring annulus to a minimum pressure of 25 psig with pure 1,1,1,2 – tetrafluoroethane (R-134a),
- Check for leakage of the inner (containment) O-ring by moving a detector probe along the interior surface of the inner seal according to the specifications of ASTM E-427.

Testing of the Vent – Optional Method

- Assemble the cask Vent Port Cap Screw and Seal per Section 7.1.
- With the vent port cover (Item 30) removed, connect to and evacuate the volume above (lid exterior) the Vent Port Cap Screw and Seal (Items 26 and 27) to 20" Hg vacuum (minimum)
- Pressurize the volume to a minimum pressure of 25 psig with pure 1,1,1,2 – tetrafluoroethane (R-134a),
- Check for leakage of the Vent Port Cap Screw and Seal by moving a detector probe along the interior surface of the Primary Lid in the area of the vent port according to the specifications of ASTM E-427.

The requirements for Periodic and Maintenance Leak Testing of the 8-120B are summarized in Table 8-1.

Table 8-1 - Periodic and Maintenance Leak Test of 8-120B

Component	Test Gas	Max. Leak Rate(1)	Minimum Sensitivity(1)	Test Pressure	Procedure	Alternate Procedure
Lid	R-134a	Fig. 4.3	Fig. 4.4	Evacuate cask cavity to 20" Hg then pressurize to 25 psig.	After pressurizing the cask cavity with the test gas, check for gas leakage from the cask Lid inner O-ring using the cask Lid test port.	After pressurizing between the lid O-ring annulus with the test gas, check for gas leakage from the cask Lid inner O-ring using a detector probe.
	Helium	Fig. 4.6	Fig. 4.7	Evacuate cask cavity to 20" Hg, or 90% vacuum for the leak tight test, then pressurize to 1 psig.	After pressurizing the cask cavity with the test gas, check for gas leakage from the cask Lid inner O-ring using the cask Lid test port.	N/A
Vent Port	R-134a	Fig. 4.3	Fig. 4.4	Evacuate cask cavity to 20" Hg then pressurize to 25 psig.	After pressurizing the cask cavity with the test gas, check for gas leakage from the Vent Port and Seal.	After pressurizing the volume above the Vent Port Cap Screw and Seal with the test gas, check for gas leakage from the vent penetration on the inner side of the lid using a detector probe.
	Helium	Fig. 4.6	Fig. 4.7	Evacuate cask cavity to 20" Hg, or 90% vacuum for the leak tight test, then pressurize to 1 psig.	After pressurizing the cask cavity with the test gas, check for gas leakage from the Vent Port Cap Screw and Seal.	N/A

Notes:
(1) Shipments of powdered radioactive materials shall be performed only when the most recent periodic leak test meets the requirements of Section 8.3.2.1 for leaktight status.

8.3.2.2 Pre-Shipment Leak Test

a. This test is required before every 8-120B cask shipment to verify that the containment system has been assembled properly.

b. The test will be performed by pressurizing the annulus between the O-ring seals of each lid, or inlet to the vent port with dry air or nitrogen to 18 psig.

Note: The pre-shipment leak test is typically performed using a test manifold that may be constructed from tubing, fittings, isolation valves and a pressure gauge. Any test apparatus used for this test must have an internal volume, with isolation valves closed and the apparatus connected to the test port location, of less than or equal to 10 cm^3 to achieve the required test sensitivity for the hold time specified in Section 8.3.2.2.d.

Note: If air is used for the test, the air supply should be clean and dry. If it is not, or if the quality of the air supply is uncertain, the test should be performed with nitrogen to ensure reliable results.

c. The test shall be performed using a pressure gauge, accurate within 1%, or less, of full scale.

d. The test pressure shall be applied for at least 15 minutes for the lid or vent port. A drop in pressure of greater than 0.1 psig shall be cause for test failure.

e. Sensitivity at the test conditions is equivalent to the prescribed procedure sensitivity of 10^{-3} ref-cm^3/sec based on dry air at standard conditions as defined in ANSI N14.5-1997.

Table 8-2 summarizes pre-shipment leak test requirements for the 8-120B:

Table 8-2 - Pre-Shipment Leak Test of 8-120B Components

Component	Hold Time	Procedure
Lid	15 min.	Connect test manifold to the test port. Pressurize void between O-rings with the test gas, close the isolation valves and hold for the minimum hold time. A drop in pressure of greater than the minimum detectable amount shall be cause for test failure.
Vent Port	15 min.	Remove the threaded cap covering the vent port. Connect test manifold to the vent port. Pressurize the seal and head of the vent port cap screw for the minimum hold time. A drop in pressure of greater than the minimum detectable amount shall be cause for test failure.

8.3.3 COMPONENT AND MATERIAL TESTS

Cask seals (O-rings) are inspected each time the cask lids or vent port cap screw are removed. Inspection and replacement of the seal is discussed in Section 8.3.

New seals are lightly coated with a lightweight lubricant such as Parker Super O-Lube or equivalent prior to installation. The lubricant will minimize deterioration or cracking of the elastomer during usage and tearing if removal from the dovetail groove is necessary for inspection. Coating the exposed surfaces of installed lid seals with the lightweight lubricant immediately prior to closing the lid can help to minimize deterioration or cracking of the seal during use. Excess lubricant should be wiped off before closing the lid.

Painted surfaces, identification markings, and match marks used for closure orientation shall be visually inspected to ensure that painted surfaces are in good condition, identification markings are legible, and that match marks used for closure orientation remain legible and are easy to identify.

Visible cask external and cavity welds shall be inspected within twelve months prior to use to verify that the welds specified by the applicable cask drawing are present and that no obvious weld defects are visible. If paint is covering these welds, the inspection may be completed without removing the paint.

8.3.4 THERMAL TESTS

No periodic or routine thermal testing will be performed on the 8-120B packaging.

8.3.5 MISCELLANEOUS TESTS

8.3.5.1 Repair of Bolt Holes

Threaded inserts may be used for repair of bolt holes. The following steps shall be performed for each repair using a threaded insert.

a. Install threaded insert(s), sized per manufacturer's recommendation, per the manufacturer's instructions.

b. At a minimum, each repaired bolt hole(s) will be tested for proper installation by assembling the joint components where the insert is used and tightening the bolts to their required torque value.

   Note: If the repair is to bolt holes for lifting components, then a load test will also be performed to the affected components equal to 150% of maximum service load.

c. Each threaded insert shall be visually inspected after testing to insure that there is no visible damage or deformation to the insert.

8.4 REFERENCES

8.4.1 Energy*Solutions* Specification ES-M-175, "Polyurethane Foam Specification."
8.4.2 EnergySolutions Specification ES-C-038, "8-120B Seal Specification."

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Section 5

Drawings

Drawings withheld as security-related sensitive information.

Section 6

References

ENERGYSOLUTIONS

Letterbook No.: ES/NRC 13-010
Docket No. 71-9168
May 23, 2013

ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Amendment Request for Certificate of Compliance No. 9168 for the Energy*Solutions* 8-120B Type B Shipping Package**

References: (1) Certificate of Compliance No. 9168, Revision 19, Docket No. 71-9168, Package Identification No. USA/9168/B(U)-96, Dated August 23, 2012.

(2) Safety Analysis Report for the Model 8-120B Shipping Packaging, Consolidated Revision 3, July 2012.

Dear Sir or Madam:

Energy*Solutions* hereby submits an application to amend Certificate of Compliance (CoC) for the Model 8-120B Shipping Package (Reference 1). The application requests the addition of a steel plate that covers the central hollow region of the lower impact limiter and is credited for radiation shielding under NCT. The application provides a revised shielding evaluation, which includes the effects of the added plate, along with some other existing components of the packaging that were conservatively ignored in the previous shielding evaluation. In addition, the application includes editorial corrections to the 8-120B SAR (Reference 2). Finally, the application deletes the July 2012 SAR Addendum, as it will no longer be applicable under the requested CoC amendment. A summary of the specific proposed changes to the 8-120B SAR is provided in Attachment 1 of this letter.

Enclosure 1 contains one (1) paper copy of the non-public version of the revised SAR that contains security-related sensitive information that should be withheld under 10 CFR 2.390. Enclosure 2 contains one (1) paper copy of the public version of the revised SAR in which all proprietary information and security-related sensitive information is redacted. Enclosure 3 contains one (1) paper copy of the revised shielding analysis for the 8-120B cask, which contains proprietary information. An affidavit containing a full statement of the reasons that the proprietary information should be withheld from the public, pursuant to the requirements of 10 CFR 2.390, is included in Attachment 2 of this letter.

2105 South Bascom Ave., Suite 230 • Campbell, California 95008
408.558.3500 • Fax 408.558.3518 • www.energysolutions.com

Should you or your staff have questions, please contact the undersigned.

Sincerely,

Steven E. Sisley
Licensing Manager
Energy*Solutions* Products and Technology Group
(408) 558-3509
E-Mail: ssisley@energysolutions.com

Attachments:
(1) Summary of Changes, 8-120B Consolidated SAR, Revision 4 (4 pages)
(2) Affidavit pursuant to 10 CFR 2.390

Enclosures:
(1) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 4, May 2013, Non-Public Version (1 paper copy), **(Security-Related Information – Withhold Under 10 CFR 2.390),**
(2) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 4, May 2013, Public Version (1 paper copy).
(3) Energy*Solutions* Calculation Package, "8-120B Shielding Response," Document No. CALC NU-391, Revision 6 (1 paper copy), **(Proprietary– Withhold Under 10 CFR 2.390).**

cc: Mr. Pierre Saverot, Division of Spent Fuel Storage and Transportation
Mr. Dan Shrum, Energy*Solutions*

Summary of Changes, 8-120B Consolidated SAR, Revision 4

Section	Page(s)	Change	Purpose
Front Matter	xiv	Added blank page.	Editorial – formatting for two-sided printing.
1.2.1	1-1	Expanded description of impact limiter skin and cover plates.	Revised for clarity.
1.2.1.3	1-3	Changed maximum payload weight.	Reduced to offset additional weight of plate added to lower impact limiter in order to maintain maximum package weight.
1.2.1.5	1-3	Deleted comma from section heading	Editorial correction.
1.3	1-7	Added list of drawings included in SAR.	Editorial – for clarity.
---	1-8	Added blank page.	Editorial – formatting for two-sided printing.
1.3	---	Revised Dwg. No. C-110-E-0007: 1) Added ½-inch thick plate (Item 56) to cover central region of the Lower Impact Limiter, 2) Revised thickness of impact limiter skin, and 3) Removed non-critical dimensions on the impact limiter lift lug (Items 45A and 46.)	Purposes of drawing changes are as follows: 1) Plate added for shielding, 2) Editorial correction for consistency with safety analyses, and 3) Removed dimensions not used in Safety Analyses.
2.1.1	2-2	Revised "Impact Limiter" section to discuss plates covering the central regions of the upper and lower impact limiters.	Revised for clarity.

Summary of Changes, 8-120B Consolidated SAR, Revision 4

Section	Page(s)	Change	Purpose
2.1.3	2-4	Changed section for the following: 1) Changed the word "conservative" to "nominal" in first sentence, 2) Reduced "Payload" weight to offset additional weight of plate added to lower impact limiter, 3) Deleted separate line for "Thermal Shield" weight and combined weight of the thermal shield and plate added to lower impact limiter in "Misc." line, and 4) Added discussion of possible shift in package center of gravity due to eccentric payload configurations.	Purposes of revisions to section are as follows: 1) Weights are based on nominal dimensions. 2) Maintain overall package weight within limit. 3) Simplify weight summary. 4) Added to clarify that the effect of payload configuration on the package center of gravity is not significant and does not require separate evaluations of payload configurations.
2.6.10	2-28	Changed to include thicknesses of the weather cover on the impact limiter and the plate added to the lower impact limiter.	Address impact of penetration test on impact limiter cover plates.
2.7.8	2-57	Add discussion of damage to impact limiter covers resulting from HAC puncture test.	Added for completeness and consistency with existing safety analyses.
Figure 2-1	2-85	Changed graphic to show cover plate on lower impact limiter.	More accurately depict design configuration.
Figure 2-5	2-89	Added figure caption.	Editorial – figure caption missing in previous SAR revision.
3.1.1	3-1	Changed discussion to include the plate added to the lower impact limiter.	Added for completeness and consistency with existing safety analyses.

Summary of Changes, 8-120B Consolidated SAR, Revision 4

Section	Page(s)	Change	Purpose
3.4	3-6	Added discussion of potential damage to impact limiter cover plates resulting from the HAC puncture test and the damaged configuration considered in the HAC fire evaluation.	Added for completeness and consistency with existing safety analyses.
---	3-38	Added blank page.	Editorial – formatting for two-sided printing.
5.1.1	5-1	Changed to discuss shielding design features of the radial thermal barrier, impact limiter skins, and plate added to lower impact limiter.	Components are credited for shielding in the revised shielding evaluation.
Table 5-1	5-2	Changed package dose rate results.	Updated based on results of revised shielding evaluation.
5.1.2.2	5-2	Expanded parenthetical discussion of point source modeling.	Clarify reason for point source location.
5.1.2.3	5-3	Changed allowable source strengths.	Updated based on results of revised shielding evaluation.
5.3.1.1	5-4	Revised 2nd sentence to discuss treatment of plate tolerances in shielding model.	Added for completeness and consistency with revised safety analyses.
5.4.1	5-8	Revised the discussion of conservatism in the shielding model to include modeling minimum steel plate thicknesses.	Added for completeness and consistency with revised safety analyses.
Table 5-5	5-11	Changed table to report results of revised shielding evaluation.	Updated based on results of revised shielding evaluation.
Figure 5-3	5-12	Changed figure to report results of revised shielding evaluation.	Updated based on results of revised shielding evaluation.
Figure 5-4	5-13	Changed figure to report results of revised shielding evaluation.	Updated based on results of revised shielding evaluation.
---	6-2	Added blank page.	Editorial – formatting for two-sided printing.

Summary of Changes, 8-120B Consolidated SAR, Revision 4

Section	Page(s)	Change	Purpose
Table 7-1	7-10	Changed table to report results of revised shielding evaluation.	Updated based on results of revised shielding evaluation.
Attachment 1, Example 1, Steps 5-7	7-14	Revised example data.	Updated based on results of revised shielding evaluation.
Attachment 1, Example 2, Steps 5-7	7-16	Revised example data.	Updated based on results of revised shielding evaluation.
Attachment 1, Example 3, Steps 5-7	7-18	Revised example data.	Updated based on results of revised shielding evaluation.
Attachment 1, Example 4, Steps 5-7	7-21	Revised example data.	Updated based on results of revised shielding evaluation.
Attachment 1, Example 5, Step 3	7-22 and 7-23	Revised selected example parameters.	More pertinent example chosen based on revised shielding analysis results.
Attachment 1, Example 5, Steps 5-7	7-23 and 7-24	Revised example data.	Updated based on results of revised shielding evaluation.
---		Added blank page.	Editorial – formatting for two-sided printing.
July 2012 SAR Addendum	All	Deleted.	No longer applicable.

AFFIDAVIT PURSUANT TO 10 CFR 2.390

State of California)
) SS.
County of Santa Clara)

I, Steven E. Sisley, depose and say as follows:

(1) I am Licensing Manager of Energy*Solutions* Products and Technology Group, and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been duly authorized to apply for its withholding.

(2) The information sought to be withheld is contained in the document listed in Table 1. This document has been appropriately designated as proprietary.

TABLE 1

Document No.	Document Title	Rev/Date
CALC NU-391	8-120B Shielding Response	6

(3) I have personal knowledge of the criteria and procedures used by Energy*Solutions* in designating information as trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, including the information as designated in paragraph (2) above, should be withheld.

(i) The information sought to be withheld from public disclosure is included in the report documenting information which is owned and has been held in confidence by Energy*Solutions*.

(ii) The information is of a type customarily held in confidence by Energy*Solutions* and not customarily disclosed to the public. Energy*Solutions* has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitute Energy*Solutions* policy and provide the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process or component, structure, tool, method, etc., and the prevention of its use by Energy*Solutions*' competitors, without license from Energy*Solutions*, gives Energy*Solutions* a competitive economic advantage.

(b) The information consists of supporting data (including test data) relative to a process or component, structure, tool, method, etc. and gives Energy*Solutions* a competitive economic advantage, e.g., by optimization or improved marketability.

(c) The information, if used by a competitor, would reduce the competitor's expenditure of resources or improve the competitor's advantage in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

(d) The information reveals cost or price information, production capacities, budget levels, or commercial strategies of Energy*Solutions*, its customers or suppliers.

(e) The information reveals aspects of past, present, or future Energy*Solutions* or customer funded development plans and programs of potential commercial value to Energy*Solutions*.

(f) The information contains patentable ideas, for which patent protection may be desirable.

(g) The information is third-party Proprietary Information.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked and being transmitted by Energy*Solutions* to the Document Control Desk. The proprietary information has been presented to the Nuclear Regulatory Commission and is being voluntarily provided by Energy*Solutions*.

(vi) Public disclosure of the information is likely to cause substantial harm to the competitive position of Energy*Solutions* because:

(a) Similar products are manufactured and sold by competitors of Energy*Solutions*.

(b) The development of this information by Energy*Solutions* is the result of a significant expenditure of staff effort and a considerable sum of money. To the best of my knowledge and belief, a competitor would have to undergo similar effort and expense in generating equivalent information.

(c) In order to acquire such information, a competitor would also require considerable time and inconvenience.

(d) The information consists of detailed descriptions, properties and test data. The availability of such information to competitors would enable them to modify their product to better compete with Energy*Solutions*, take marketing or other actions to improve their product's position or impair the position of Energy*Solutions*' product, and avoid developing fabrication data in support of their processes, methods, and/or apparatus.

(e) In pricing Energy*Solutions*' products and services, significant research, development, engineering, analytical, licensing, fabrication, quality assurance and other costs must be included. The ability of Energy*Solutions*' competitors to utilize such information without similar expenditure of resources may enable them to sell their product at prices reflecting significantly lower costs.

Further the deponent sayeth not.

I declare under penalty of perjury that the forgoing is true and correct.

Executed on 23 May 2013

Date

Steven E. Sisley
Licensing Manager
Energy*Solutions* Products and Technology Group

ENERGYSOLUTIONS

Letterbook No.: ES/NRC 13-013
Docket No. 71-9168
July 3, 2013

Mr. Pierre Saverot
U.S. Nuclear Regulatory Commission
Division of Spent Fuel Storage and Transportation/Licensing Branch
3 White Flint North Building
11601 Landsdown Street
MS 3WFN-14A44
North Bethesda, MD 20852

Subject: **Inadvertent Omissions from Amendment Request for Certificate of Compliance No. 9168 for the Energy*Solutions* 8-120B Type B Shipping Package**

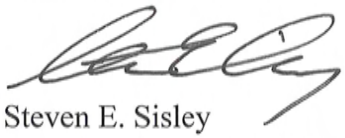
Reference: Letter from Energy*Solutions* (S. Sisley) to NRC, Subject: Amendment Request for Certificate of Compliance No. 9168 for the Energy*Solutions* 8-120B Type B Shipping Package, Letterbook No. ES/NRC 13-010, May 23, 2013.

Dear Mr. Saverot:

Per the referenced letter, Energy*Solutions* submitted a request to NRC to amend Certificate of Compliance (CoC) for the Model 8-120B Shipping Package. The request included both public and non-public versions of Consolidated Revision 4 of the Safety Analysis Report (SAR) for the Model 8-120B Type B Shipping Packaging. Subsequent to the submittal, inadvertent omissions were identified in Chapter 7 of the SAR. Enclosed is an electronic copy of the SAR change pages that should be substituted in both the public and non-public versions of Consolidated Revision 4 of the Safety Analysis Report for the Model 8-120B Type B Shipping Packaging. In addition, a list of requested changes to the CoC amendment is included in the Attachment.

Should you or your staff have questions, please contact the undersigned.

Sincerely,



Steven E. Sisley
Cask Licensing Manager
Energy*Solutions* Products and Technology Group
(408) 558-3509
E-Mail: ssisley@energysolutions.com

Attachment: Requested Changes to CoC Amendment (2 pages)

Enclosure: Electronic file containing change pages 7-3 through 7-7 for Consolidated Revision 4 of the 8-120B Type B Shipping Packaging SAR (Filename *8-120B_ConRev4_inadvertent_omissions.pdf*, dated 7/3/2013).

Requested Changes to CoC Amendment

Energy*Solutions* requests the following changes to CoC No. 9168 in association with the amendment request (Reference 1), and provides the following bases for the requested changes:

Requested Change #1 (Editorial): Revise 5(b)(1)(ii) to read as follows:

> "Radioactive material in the form of activated metals, or metal oxides in solid form, contained within secondary containers."
>
> *Basis: The addition of the commas is requested for clarity.*

Requested Change #2: Remove Condition 7 of CoC Revision 19, which requires two independent physical verifications of the secondary container's closure system.

> *Basis: Step 7.1.9B, requiring two independent physical verifications of the secondary container's closure system for payloads that have a potential for hot-particle migration (e.g., activated metals or radioactive sources), has been added to Section 7.1 of Consolidated Revision 4. Therefore, Condition 7 of CoC No. 9168, Revision 19 is no longer required.*

Requested Change #3: Include an exemption equivalent to Condition 8 of CoC Revision 18 for the pre-shipment leak test of LSA material and SCO objects in the CoC amendment. ES proposes the Condition be worded as follows:

> "Prior to each shipment, the package must be leak tested in accordance with Section 8.3.2.2 of the application. For contents that meet the 10 CFR 71.4 definitions of Low Specific Activity (LSA) or Surface Contaminated Object (SCO), and also meet the exemption standard for LSA material and SCO objects in 10 CFR 71.14(b)(3)(i), the pre-shipment leak test is not required."
>
> *Basis: The Condition 8 exemption for the pre-shipment leak test of LSA material and SCO objects that was included in Revision 18 appears to have been inadvertently omitted in CoC Revision 19.*

Requested Change #4: Delete Condition 12 of Revision 19 of the CoC.

> *Basis: If the ongoing CoC amendment is approved and effective by August 31, 2013, this condition will no longer applicable because the seals authorized in CoC Revision 17 will no longer be permitted for use.*

Requested Change #5: Add a Condition allow a 90-day transition period for the addition of the steel plate to the lower impact limiter. ES proposes the Condition be worded as follows:

> The package may be used until [*insert date 90 days after the effective date on the amended CoC*] with the package design authorized in Revision 19 of the CoC (i.e., Dwg. Nos. C-110-E-0007, Revision 18 and DWG-CSK-12CV01-EG-0001-01, Revision 3),

provided that source terms for all such shipments are qualified in accordance with Consolidated Revision 3 of the Safety Analysis Report for Model 8-120B Type B Shipping Package."

Basis: Modifications to add the steel plate to the lower impact limiters of all 8-120B casks in service will be made in a timely manner after the CoC is amended. A transition period of 90-days is requested to implement this change such that cask operations can continue using the package design authorized under CoC Revision 19 with the appropriate contents radiological limits.

In addition to the changes requested above, an inconsistency has been identified between the cask reference leakage rate provided in Consolidated Revision 3 of the SAR and that stated in Section 4.1 of the SER for CoC Revision 19. In Section 4.4 of Consolidated Revision 3 of the SAR, the reference leakage rate (L_R) for the cask under Normal Conditions of Transport, which is conservatively based on Irradiated Hardware, is 2.2E-06 cm^3/sec, whereas in Section 4.1 of the SER for CoC Revision 19, a value of 1.54×10^{-6} ref-cm^3/sec is quoted. While this inconsistency should not directly affect the requirements of the Certificate, it should be corrected for the CoC amendment, if it is included in the SER.

ENERGYSOLUTIONS

August 9, 2013
ES/NRC 13-017
Docket No. 71-9168

ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Response to Request for Additional Information for the Model No. 8-120B Package, Docket No. 71-9168**

Reference: Letter from P. Saverot (NRC) to S. Sisley (Energy*Solutions*), "Request for Additional Information for the Model No. 8-120B Package, Docket No. 71-9168," July 15, 2013, ADAMS Accession Number ML13197A036.

Dear Sir or Madam:

By the referenced letter dated July 15, 2013, NRC requested that Energy*Solutions* (ES) provide additional information needed for NRC staff to complete their review of the application to amend Certificate of Compliance (CoC) No. 9168 for the 8-120B Shipping Package. ES hereby provides the additional information requested by NRC in the referenced letter, as described in Enclosures 1 and 2. Enclosure 3 contains one (1) paper copy of the non-public version of the revised 8-120B SAR that contains security-related sensitive information that should be withheld under 10 CFR 2.390. Enclosure 4 contains one (1) paper copy of the public version of the revised 8-120B SAR in which all proprietary information and security-related sensitive information is redacted. Enclosure 5 contains one (1) paper copy of the revised shielding analysis for the 8-120B cask, which contains proprietary information. An affidavit containing a full statement of the reasons that the proprietary information should be withheld from the public, pursuant to the requirements of 10 CFR 2.390, is included in Attachment 2 of this letter.

Should you or any member of your staff have questions, please contact the undersigned at (408) 558-3509.

Sincerely,

Steven E. Sisley
Cask Licensing Manager
Energy*Solutions*

2105 South Bascom Ave., Suite 230 • Campbell, California 95008
408.558.3500 • Fax 408.558.3518 • www.energysolutions.com

Attachments:
(1) Summary of Changes, 8-120B Consolidated SAR, Revision 5 (3 pages)
(2) Affidavit pursuant to 10 CFR 2.390

Enclosures:
1) Responses to Request for Additional Information.
2) Proprietary Responses to Request for Additional Information.
3) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 5, August 2013, Non-Public Version (1 paper copy), **(Security-Related Information – Withhold Under 10 CFR 2.390).**
4) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 5, August 2013, Public Version (1 paper copy).
5) Energy*Solutions* Calculation Package, "8-120B Shielding Response," Document No. CALC NU-391, Revision 7 (1 paper copy), **(Proprietary– Withhold Under 10 CFR 2.390).**

cc
Mr. Pierre Saverot, Division of Spent Fuel Storage and Transportation
Mr. Dan Shrum, Energy*Solutions*

The following is a summary of the changes incorporated in Revision 5 of the 8-120B Consolidated Safety Analysis Report. The revisions indicators in the margins of Revision 4 of the 8-120B Consolidated Safety Analysis Report have also been included in Revision 5 to indicate the cumulative changes that have been made in association with the request to amend the 8-120B CoC. However, the summary of the changes incorporated in Revision 4 of the 8-120B Consolidated Safety Analysis Report is not repeated below.

Summary of Changes, 8-120B Consolidated SAR, Revision 5

Section	Page(s)	Change	Purpose
Front matter	xiv	Added revision control sheet.	Editorial change.
2.2.1	2-5	Replaced reference to specification.	Editorial change. Appendix 1, Section 8 changed to References.
3.2.2	3-2	Corrected O-ring durometer specification (1st bullet) and replaced references to specifications (1st and 3rd bullets).	Editorial correction for consistency with drawing and Section 8 references.
Chapter 4	All	Chapter 4 has been re-typeset in its entirety. Formatting changes are not marked as revisions. All other changes are described below.	Editorial change.
4.0	4-1	Deleted "CNS" from the model designation.	Editorial change.
4.2.2	4-5	Corrected referenced equation numbers for $F_{mn}(D_{max})$ and $F_{cn}(D_{max})$.	Editorial correction.
4.2.3	4-6	Clarified basis for assumed weight used in containment calculation.	Editorial correction.
4.3	4-7	Revised heading text.	Editorial change.
4.6	4-19	Corrected equation to divide $L_{He}(T_F)$ by 2.	Editorial correction.
4.7	4-19	Revised 2nd sentence to clarify that the pre-shipment leak test of the vent port is not a condition of whether the vent port plug has or has not been removed.	Pre-shipment leak test required for all Type B shipments, except for LSA material and SCO material that is exempt under 10 CFR 71.14(b)(3)(i).

Summary of Changes, 8-120B Consolidated SAR, Revision 5

Section	Page(s)	Change	Purpose
4.7.1	4-20	Corrected units for parameter L.	Editorial correction.
Appendix 4.1	4-30	Added blank page for 2-sided printing.	Editorial change.
5.1.1	5-1	Revised 1st paragraph to discuss presence of cask cavity cladding. Deleted last sentence of paragraph.	Revised in response to RAI 5-2.
Table 5-1	5-2	Dose rates updated based on revised shielding analysis.	Revised in response to RAI 5-6
5.1.2.3	5-3	Corrected Table 5-1 cross reference in last sentence of 1st paragraph.	Editorial correction.
5.3.1.1	5-4	Revised to discuss application of tolerances, modeling of the cask cavity liner (cladding) and radial thermal barrier, and adjustments to impact limiter model to account for effects of NCT drop tests.	Revised in response to RAI 5-2 and 5-6.
5.4.1	5-8	Added text to "Analysis Method Uncertainties and Conservatisms" section to discuss results with relative error levels between 0.05 and 0.1 and tallies that do not pass all 10 statistical checks performed by MCNP.	Revised in response to RAI 5-7.
Table 5-5, Figure 5-3, Figure 5-4	5-11 thru 5-13	Updated to reflect results of revised shielding analysis.	Revised in response to RAI 5-6 and 5-7.
7.1.9B	7-3	Revised step and added footnote to clarify when the requirement is waived.	Revised in response to RAI 7-1.

Summary of Changes, 8-120B Consolidated SAR, Revision 5

Section	Page(s)	Change	Purpose
Table 7-1 and examples in Attachment 1 of Chapter 7	7-10, 7-14, 7-16, 7-18, 7-21 thru 7-24.	Updated to reflect results of revised shielding analysis.	Revised in response to RAI 5-6 and 5-7.
8.2.5	8-5	Revised to clarify required testing for containment seals (2nd bullet) and replaced reference to specification (3rd bullet).	Revised to address issue identified during inspection of fabrication activities and editorial change.
8.4	8-11	Changed section from an appendix to references.	Specifications, which were not included in the appendix, are references. The section has been revised to reflect this.

AFFIDAVIT PURSUANT TO 10 CFR 2.390

State of California)
) SS.
County of Santa Clara)

I, Steven E. Sisley, depose and say as follows:

(1) I am Licensing Manager of Energy*Solutions* Products and Technology Group, and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been duly authorized to apply for its withholding.

(2) The information sought to be withheld is contained in the document listed in Table 1. This document has been appropriately designated as proprietary.

TABLE 1

Document No.	Document Title	Rev/Date
CALC NU-391	8-120B Shielding Response	7
ES/NRC 13-017 Enclosure 2	Proprietary Responses to Request for Additional Information	August 9, 2013

(3) I have personal knowledge of the criteria and procedures used by Energy*Solutions* in designating information as trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, including the information as designated in paragraph (2) above, should be withheld.

(i) The information sought to be withheld from public disclosure is included in the report documenting information which is owned and has been held in confidence by Energy*Solutions*.

(ii) The information is of a type customarily held in confidence by Energy*Solutions* and not customarily disclosed to the public. Energy*Solutions* has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitute Energy*Solutions* policy and provide the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process or component, structure, tool, method, etc., and the prevention of its use by Energy*Solutions*' competitors, without license from Energy*Solutions*, gives Energy*Solutions* a competitive economic advantage.

(b) The information consists of supporting data (including test data) relative to a process or component, structure, tool, method, etc. and gives Energy*Solutions* a competitive economic advantage, e.g., by optimization or improved marketability.

(c) The information, if used by a competitor, would reduce the competitor's expenditure of resources or improve the competitor's advantage in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

(d) The information reveals cost or price information, production capacities, budget levels, or commercial strategies of Energy*Solutions*, its customers or suppliers.

(e) The information reveals aspects of past, present, or future Energy*Solutions* or customer funded development plans and programs of potential commercial value to Energy*Solutions*.

(f) The information contains patentable ideas, for which patent protection may be desirable.

(g) The information is third-party Proprietary Information.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked and being transmitted by Energy*Solutions* to the Document Control Desk. The proprietary information has been presented to the Nuclear Regulatory Commission and is being voluntarily provided by Energy*Solutions*.

(vi) Public disclosure of the information is likely to cause substantial harm to the competitive position of Energy*Solutions* because:

(a) Similar products are manufactured and sold by competitors of Energy*Solutions*.

(b) The development of this information by Energy*Solutions* is the result of a significant expenditure of staff effort and a considerable sum of money. To the best of my knowledge and belief, a competitor would have to undergo similar effort and expense in generating equivalent information.

(c) In order to acquire such information, a competitor would also require considerable time and inconvenience.

(d) The information consists of detailed descriptions, properties and test data. The availability of such information to competitors would enable them to modify their product to better compete with Energy*Solutions*, take marketing or other actions to improve their product's position or impair the position of Energy*Solutions*' product, and avoid developing fabrication data in support of their processes, methods, and/or apparatus.

(e) In pricing Energy*Solutions*' products and services, significant research, development, engineering, analytical, licensing, fabrication, quality assurance and other costs must be included. The ability of Energy*Solutions*' competitors to utilize such information without similar expenditure of resources may enable them to sell their product at prices reflecting significantly lower costs.

Further the deponent sayeth not.

I declare under penalty of perjury that the forgoing is true and correct.

Executed on 09-August-2013

Date

Steven E. Sisley
Cask Licensing Manager
Energy*Solutions*

The responses to the NRC Request for Additional Information (RAI) associated with the Energy*Solutions* request to amend the Certificate of Compliance (CoC) for the Model No. 8-120B Shipping Package are provided herein. The NRC RAI questions, which are shown in *italics*, are followed by the ES response and a summary of the resulting changes to the 8-120B Safety Analysis Report.

CHAPTER 5 SHIELDING EVALUATION

5-1. Provide additional information on the radial thermal barrier.

Page 5-1 of the application states: "The impact limiters and radial thermal barrier provide a small amount of additional shielding." From Drawing C-11 0-E-0007, Rev. 19, sheet 4, it does not appear that the radial thermal barrier goes around the entire circumference of the package.

Clarify this drawing and state what is present (if anything) where there is no thermal barrier. Regulations limiting dose rates apply to all points on the package. Justify that the shielding model is bounding for places where there is no thermal barrier.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 10 CFR 71.51(a)(2).

Response to 5-1:

The radial thermal barrier is a 3/16" thick steel sheet that is supported above the cask outer shell by a spiral of 5/32" diameter wire wrapped around the outer shell body. The thermal barrier does encircle the whole cask body. There are notches around the four lift lug pads (items 11) and four tie down lugs (items 10).

Our criteria for determining when to model discontinuities in shielding are whether a standard 3" ion chamber survey instrument would detect a significant increase over the discontinuity, whether the discontinuity is in an area of interest (i.e., potentially governing), and the amount of shielding material missing due to the discontinuity. In this case, the discontinuities are in an area of interest, but the amount of shielding lost in the notches is small and more than compensated by the thick lift lug pads, tie down lugs, and seal welds. The lift lug pads are 2" thick plate, and the notch area is significantly filled with weld metal due to the specified ½" cover fillet weld on the lift lug plate and the radial thermal barrier seal weld (which must seal the 3/16" plate and the 5/16" standoff). A standard survey instrument would read a significant drop over the notch area due to the extra shielding afforded by the plate and weld material. Likewise, the tiedown lugs would have a lower survey reading over the notch because they are 1-1/2" thick plate, and the thermal barrier is also seal welded. The notches are therefore not modeled in the shielding analysis.

Summary of SAR changes:

- No changes

5-2. List all differences between the shielding model for the previous revision of the CoC and the current application for both NCT and hypothetical accident conditions (HAC).

This information is required by the staff to determine compliance with 10 CFR 71.47 and 10 CFR 71.51(a)(2).

Response to 5-2:

The changes to the shielding model are as follows:

- The new ½" thick carbon steel shield disk is modeled in the hollow end section of the lower impact limiter. This disk is only modeled in the NCT analyses.

- The impact limiter steel casing, which is 12-gauge sheet, is now modeled in the NCT cases only. The dimensions used account for NCT deformations (see Response to 5-6). The impact limiter foam is still conservatively neglected.

- The 12-gauge steel cladding that covers the top, bottom and radial surfaces of the cask inner cavity is now modeled in both the NCT and HAC analyses. Because we have taken credit for the cladding, we have also deducted the maximum tolerances from the sheet and plate (discussed further below).

- The 3/16" thick radial thermal shield, which covers the axial section of the cask body that lies between the impact limiters, is now modeled in both the NCT and HAC analyses.

Because we are including steel which has previously been neglected, the NCT and HAC models were also revised to account for thickness tolerances in the steel cask components. This change resulted in small changes to many of the modeled coordinates. In most cases, the minimum plate tolerances were modeled. The bolt ring (drawing item 4), however, is conservatively modeled at the maximum thickness tolerance, as this raises the lid relative to the top of the lead. Similarly, the thickness of the seal wear plate (drawing item 9) was increased to its maximum thickness, which conservatively raises the lid (and more importantly the point-sources) relative to the top of the lead. The effects of the changes on the dose rate response are discussed in the response to 5-5.

Summary of SAR changes:

- Text is added to Section 5.1.1 which discusses the presence of the cask cavity liner.

- Text is added to Section 5.3.1.1 which discusses the application of tolerances, as well as the modeling of the cask cavity liner and radial thermal barrier.

5-3. Refer to proprietary enclosure.

Response to 5-3:

Refer to proprietary Enclosure 2.

5-4. Refer to proprietary enclosure.

Response to 5-4:

Refer to proprietary Enclosure 2.

5-5. Explain why the dose rate response (i.e., mrem/hr per photon/s, calculated by MCNP) increases for some configurations.

Given the increase in shielding modeled all around the package for the calculations presented in the application, the staff expects, in every calculation, that the peak dose rate response (i.e., mrem/hr per photon/s, calculated by MCNP) would decrease from previous levels associated with Rev. 19 of the CoC. However, the review of Tables 9.3-1 through 9.3-11 in CALC NU-391, Rev. 6, and their comparison to the same tables in Rev. 5 of the same document, shows that, in some cases, this value increases for the lower energy gammas and ^{137}CS. Discuss why this happens. If this is due to large uncertainties associated with calculating small dose rate responses, discuss the process used to ensure that the dose rate response used to control the source limit is an accurate or conservative value. See also RAI 5-4.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 10 CFR 71.51(a)(2).

Response to 5-5:

The changes are not due to large calculational uncertainties. As discussed in the response to RAI 5-2, we applied plate and sheet tolerances in these models since we took credit for the additional steel. When we looked at how to apply the tolerances for the cask flange area, we concluded that it would be non-conservative to use the minimum thicknesses for drawing items 4 and 9 because that would move the lid lower, pushing the source lower with respect to the top of the lead for the point-source cases. So we instead used maximum material thicknesses for items 4 and 9. This actually moved the lid/point-source upwards slightly, resulting in more streaming over the top of the lead. This drove the responses up for Cs-137 and the softer gamma energies, whose peaks occur up above the edge of the lead. Higher energy gammas peak at the cask midplane and were therefore not similarly affected.

Summary of SAR changes:

- None.

5-6. Discuss the effects of NCT on the thermal barrier and impact limiter models. Discuss the modeling of the impact limiter.

The comparison of the drawing C-110-E-0007, Rev. 19, with the drawing in Appendix 1 of CALC NU-391, shows that nominal dimensions of the impact limiter were used in the shielding calculation. Verify if this is correct.

Table 2-10 of the application indicates that there is some deformation of the impact limiter as a result of NCT drop tests. Discuss if the results of the NCT tests were included in the impact limiter models and justify if these are not. Discuss the result of the NCT tests on the thermal barrier and if these effects were included in the shielding models.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 10 CFR 71.51(a)(2).

Response to 5-6:

Yes, the nominal (un-deformed) impact limiter dimensions were modeled in the shielding analyses of the CALC NU-391, Rev. 6 calculations.

To ensure that no calculated cask source limits are non-conservative, due to the effects of the tests/conditions defined for NCT, all of the NCT shielding analyses have been re-performed. The revised analyses account for the permanent deformations of the impact limiters under NCT, presented in Table 2-10 of the application. Specifically, the bottom and top impact limiters' outer radii are reduced by 1.3 inches (from 51 inches to 49.7 inches), and the thickness of the bottom and top impact limiter end regions is reduced by 1.3 inches (from 22 inches to 21.4 inches). For simplicity, the very local, additional crush that may occur in the impact limiter corners is not modeled, because that location has relatively low dose rates that are always non-controlling by a wide margin. The revised shielding analysis is presented in Rev. 7 of the NU-391 calculation package, which is provided as part of this RAI response package.

The structural analyses do not show that there are any permanent impacts or deformations of the thermal barrier. Thus, the shielding analyses model the un-deformed configuration of the thermal barrier, as described in the SAR drawings.

Summary of SAR changes:

- Text is added to Section 5.3.1.1 which discusses the adjustments to the impact limiter dimensions, to account for the effects of the NCT drop tests.

- The dose rates presented in Table 5-1 are updated to reflect the revised shielding analysis.

- The payload source limit results presented in Table 5-5 and in Figures 5-3 and 5-4 are updated to reflect the revised shielding analysis.

- Table 1 and the examples in Chapter 7 are updated to reflect the revised shielding analysis.

5-7. Provide additional information justifying that the MCNP calculations have converged properly.

The staff found, from the MCNP input files, that various computing time cut-off (ctme) values were specified. Describe the procedure used to ensure that the MCNP calculations have properly converged. This procedure should include a discussion on how the figure of merit (FOM) and 10 statistical checks were used to ensure the quality of the precision of the calculation and the steps taken when any checks have failed.

Provide the relative error (R value) for all calculations presented in Tables 9.3-1 through 9.3-11 in CALC NU-391, Rev. 6. The MCNP manual states that R values greater than 0.1 are not reliable. Justify the calculations for any R value greater than 0.1.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 10 CFR 71.51(a)(2).

Response to 5-7:

We run lower gamma energy cases longer in order to improve statistics. The non-azimuthally-symmetric cases (i.e., top corner source cases) also require more run time since the dose rates are tallied over narrow axial strips which lie at the azimuth of the source point, whereas the azimuthally-symmetric cases can employ larger tally areas that extend over the entire (360-degree) azimuthal span of the cask exterior surfaces.

In order to ensure that MCNP calculations have properly converged, the following steps are taken:

- MCNP responses are examined to see if they behave predictably, without unexpected sudden changes or large variations.

- The code output is examined to ensure that important features such as streaming paths or shielding discontinuities are adequately sampled.

- When tallies have relative error levels over 0.10, or when they do not pass all statistical checks, the results are questioned and evaluated as described below.

Relative Error Levels

Table 2.4 from the MCNP User's Manual (see below) describes the tally quality associated with different ranges of relative error. Tallies with high relative errors are disregarded if there is good reason to neglect them (e.g., not an area of interest). If there is no justification to disregard them, the model is corrected and re-run.

Table 2.4
Guidelines for Interpreting the Relative Error R[a]

Range of R	Quality of the Tally
0.5 to 1	Garbage
0.2 to 0.5	Factor of a few
0.1 to 0.2	Questionable
< 0.10	Generally reliable except for point detector
< 0.05	Generally reliable for point detector

[a] $R = S_{\bar{x}}/\bar{x}$ and represents the estimated statistical relative error at the 1σ level. These interpretations of R assume that all portions of the problem phase space have been well sampled by the Monte Carlo process. Please use statistical checks for detailed information.

All of the dose rate results presented in the NU-391 shielding calculation are calculated using area detectors, as opposed to point (or ring) detectors. Thus, results with relative error levels under 0.1 are generally reliable.

Results with MCNP-output relative error levels over 0.1 are examined to determine if they have any potential to affect the conclusions of the analysis. Based on the above table from the MCNP User's Manual, results with relative error levels between 0.1 and 0.2 may be acceptable if they would have to increase by a factor of two or more before they would affect any payload source limit results. Results with relative error levels between 0.2 and 0.5 may be acceptable if they would have to increase by several orders of magnitude before they would affect any payload source limit results.

Examination of the NU-391, Rev. 6 shielding analysis results (submitted to NRC with the initial license amendment application) shows that 17 individual tally segment results (out of a total of over 10,000) had relative error levels over 0.1. These results occurred over eight tally surfaces, with three of the eight surfaces having four tally segments with relative error levels over 0.1. All but one of these 17 individual tally segment results had relative error levels between 0.10 and 0.14. All of those 16 results would have to increase by a factor of ~2 or more before they would affect any of the payload source limit results. The one remaining result had a relative error level of almost 0.24, but it would have to increase by a factor of over 1000 before it would affect any of the payload source limit results.

Based on the above, it was concluded that the small number of results with relative error levels over 0.1 were acceptable. However, in order to eliminate any doubts as to the adequacy or reliability of the dose rate results, the cases which produced those results with relative error levels over 0.1 were re-performed with longer computer runtimes for this submittal. In the revised shielding analyses, presented in Rev. 7 of the NU-391 calculation package, none of the (over 10,000) individual dose rate results have relative error levels over 0.1.

A set of tables similar to Tables 9.3-1 through 9.3-11 (of the NU-391 calculation) are attached to this RAI response. In each box of each table, the relative error level for each result (as opposed to the dose response itself) is presented. Refer to Tables 9.3-1 through 9.3-11 of the Rev. 7, NU-391 calculation package to see the dose rate responses (in mrem/hr per source gamma/sec). Note that the relative error levels presented in the attached tables correspond to the Rev. 7 calculations. None of the relative error levels exceed 0.1. Also note that, although they appear in some of the boxes in Tables 9.3-1 through 9.3-11, none of the dose rate responses with relative error levels between 0.05 and 0.1 govern any of the payload source limits. All source limits are governed by dose rate results with error levels under 0.05.

MCNP Statistical Checks

The MCNP User's Manual states that if "several" of the 10 statistical checks for a given tally do not pass, the confidence intervals output by the code for the individual tally segment results are "less likely to be correct". In other words, the degree of precision in the dose rate results may be somewhat less than that suggested by the code-output relative error levels. The manual states that some things which result in a missed check, such as small changes in FOM, do not necessarily indicate an inaccurate result. The manual does not give any specific, quantitative criteria for addressing results that do not pass all 10 checks.

Our practice is that tallies that do not pass all 10 statistical checks performed by MCNP are examined to determine if they contain tally segment results (peak dose rates) that have any potential to affect the conclusions of the analysis. Also, the dose rate profiles on such surfaces are examined to see if they exhibit any unpredictable or unexpected behavior. Results that do not pass all 10 checks are accepted if the dose rate profiles are predictably-behaved, and if the dose rate response would have to increase substantially (i.e., by an amount much larger than the size of the confidence interval output by MCNP) before they would govern any of the payload source limit results.

Evaluation of Rev. 6 Results:

Examination of the NU-391, Rev. 6 shielding analysis results (submitted to NRC with the initial license amendment application) shows that 43 of the over 500 tallies did not pass 1-3 of the 10 statistical checks performed by MCNP. Only three of the cases missed 3 of the 10 checks, whereas four of the cases missed 2 of the 10 checks. The other 36 cases missed only one check.

Furthermore, only six of the tallies contained a tally segment result that governed any of the payload source limits presented in Table 6.1-1 of the NU-391 calculation. For all other cases, the peak tally segment (dose rate) result would have had to increase by more than 20 times the relative error level before it would govern any of the payload source limit results. It was concluded that the non-governing tallies were acceptable, as it was not deemed credible that the MCNP-output confidence intervals were a factor of 20 or more too low because 1-3 of the 10 statistical checks were missed.

Evaluation of Rev. 7 Results:

As discussed in the response to RAI 5-6, all the NCT cases were rerun with adjusted impact limiter dimensions. Also, as discussed above in this response, some of the HAC cases were rerun, with longer computer run times. The new analysis results are presented in the NU-391, Rev. 7 calculation package. These new results were also examined to check for passage of the 10 statistical checks.

Examination of the Rev. 7 shielding analysis results showed that 47 of the (~500) tallies did not pass all 10 checks. Two tallies missed three checks, 6 tallies missed two checks and the remaining (39) tallies only missed one check. All non-governing tallies would have to increase by over seven times their relative error level before they would affect any of the payload source limit results. Four of the tallies, all of which missed only one check, were governing tallies (that contained tally segment dose rate responses that determined one of the payload source limits). Examination of the dose rate response results/profiles for those four cases showed that results were all well-behaved. Also, the tally segment results in all four tallies also have very low relative error levels (~1% or less).

Three of those four tallies missed one check because there was a trend in the figure of merit (FOM) over the last half of the run. Examination of the FOM trends showed that the variations in FOM were very small (0.6% to 2.6%). The MCNP manual states that "small jumps in R, VOV and/or the FOM as a function of N are not threatening to the quality of the result". On this basis, it is concluded that those three tallies are acceptable. The fourth tally missed one check due to trend in the estimated mean over the last half of the run. The estimated mean results were examined and they did not show any significant variation or trend.

On the basis of all the above, it was concluded that the four governing tallies that did not pass all 10 statistical checks are acceptable. The uncertainty in those dose rate response results due to missed statistical checks is judged to be less than 1%, which is offset by adding the relative error to the response. Plus as discussed in Appendix 8 of the NU-391 calculation, a 5% administrative margin is applied which more than offsets the potential uncertainties in the analysis.

Summary – For Rev. 7 Analysis Results

The following applies for the revised shielding analysis results, presented in Rev. 7 of the NU-391 calculation, a copy of which is included in this RAI response.

- All dose rate results have relative error levels under 0.1.

- All dose rate results that govern any of the final, payload source limit results (presented in Table 6.1-1 of the calculation) have relative error levels under 0.05.

- Only four of the tally surfaces that govern any of the final, payload source limit results (presented in Table 6.1-1 of the calculation) miss only one of the 10 the statistical checks performed by MCNP. Any potential uncertainties in those four results are judged to be very small, as discussed above.

- All non-governing results from tallies that do not pass all 10 statistical checks would have to increase substantially (by over seven times the MCNP-output relative error level) before they would affect any of the payload source limit results.

Summary of SAR changes:

- Text is added to the "uncertainties and conservatisms" section of Section 5.4.1, which briefly discusses results with relative error levels between 0.05 and 0.1, and tallies that do not pass all 10 statistical checks performed by MCNP.

- The payload source limit results presented in Table 5-5, Figures 5-3 and 5-4, and Table 1 of Chapter 7 are updated to reflect the new results for the few cases that were re-performed, with a longer computer runtime, to improve result statistics.

CHAPTER 7 OPERATING PROCEDURES

7-1. Modify the language in proposed revision to Operating Procedure 7.1.9B regarding the closure of the secondary system.

By letter dated July 3, 2013 (ADAMS Accession No. ML 13189A107), ES proposed a revision to Condition 7 of Rev. 19 of the CoC by deleting this condition and adding step 7.1.9B to the Operating Procedures. The staff finds in principle that adding this step to the operating procedures (as opposed to being a CoC condition) is acceptable; however, the staff finds that the proposed language is ambiguous. Specifically: "For shipments of payloads that have a potential for hot-particle migration (e.g., activated metals or radioactive sources) ... " could have multiple interpretations. Clarify this language and modify it to remove any ambiguity.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 10 CFR 71.51(a)(2).

Response to 7-1:

We propose the change Step 7.1.9B to say "Perform two independent physical verifications of the secondary container's closure system to ensure that it is properly closed and secured. This requirement is waived for uniformly distributed resins, filters, and for solidified wastes larger than 1 cm." We will add a footnote indicating that the basis for the size is that the source for certain shielding models was assumed to be 1 cm in size.

Summary of SAR changes:

- Revise Step 7.1.9B.

Attachment

Relative Error Tables
For Revision 7 of NU-391

Allowable Source Derivation for Co-60										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-Co60-fullcav	NCT-Co60-25ft3t	NCT-Co60-55gal	NCT-Co60-pt-ctr	NCT-Co60-pt-tcor	NCT-Co60-pt-side	HAC-Co60-fullcav	HAC-Co60-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	0.5%	0.4%	0.4%	0.3%	2.0%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	0.7%	0.6%	1.6%	0.6%	0.6%	N/A	N/A	N/A
NCT	Surface	Side (body)	1.1%	0.3%	0.4%	0.3%	4.9%	0.9%	N/A	N/A
NCT	Surface	Top	1.3%	1.3%	1.3%	0.9%	1.9%	N/A	N/A	N/A
NCT	Surface	Bottom	1.2%	1.3%	1.4%	0.9%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	0.3%	1.3%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	1.4%	2.3%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	1.2%	N/A

Allowable Source Derivation for Cs-137										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-Cs137-fullcav	NCT-Cs137-25ft3s	NCT-Cs137-55gal2	NCT-Cs137-pt-ctr	NCT-Cs137-pt-tcor	NCT-Cs137-pt-side	HAC-Cs137-fullcav	HAC-Cs137-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	0.4%	3.2%	2.4%	2.1%	2.2%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	2.9%	2.6%	1.9%	1.7%	0.7%	N/A	N/A	N/A
NCT	Surface	Side (body)	3.0%	1.0%	0.8%	0.5%	3.3%	2.5%	N/A	N/A
NCT	Surface	Top	1.0%	0.8%	0.5%	0.5%	1.4%	N/A	N/A	N/A
NCT	Surface	Bottom	1.0%	0.8%	0.6%	0.5%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	6.7%	1.4%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	1.3%	2.2%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	1.1%	N/A

Allowable Source Derivation for 3.5 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-350-fullcav	NCT-350-25ft3t	NCT-350-55gal	NCT-350-pt-ctr	NCT-350-pt-tcor	NCT-350-pt-side	HAC-350-fullcav	HAC-350-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	0.8%	0.5%	0.6%	0.4%	0.8%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	1.0%	0.9%	1.0%	0.9%	0.4%	N/A	N/A	N/A
NCT	Surface	Side (body)	1.1%	0.4%	0.5%	0.2%	8.8%	0.7%	N/A	N/A
NCT	Surface	Top	2.6%	2.5%	2.6%	1.3%	0.9%	N/A	N/A	N/A
NCT	Surface	Bottom	1.9%	2.0%	2.6%	1.4%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	0.5%	0.5%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	1.8%	1.4%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	2.7%	N/A

Allowable Source Derivation for 2.75 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-275-fullcav	NCT-275-25ft3t	NCT-275-55gal	NCT-275-pt-ctr	NCT-275-pt-tcor	NCT-275-pt-side	HAC-275-fullcav	HAC-275-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	0.6%	0.4%	0.5%	0.3%	0.9%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	0.7%	0.6%	0.7%	0.4%	0.4%	N/A	N/A	N/A
NCT	Surface	Side (body)	1.0%	0.3%	0.4%	0.2%	8.8%	0.5%	N/A	N/A
NCT	Surface	Top	1.7%	1.8%	1.8%	1.0%	1.0%	N/A	N/A	N/A
NCT	Surface	Bottom	1.8%	1.9%	1.8%	1.1%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	0.6%	1.8%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	3.5%	4.5%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	3.1%	N/A

Allowable Source Derivation for 2.25 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-225-fullcav	NCT-225-25ft3t	NCT-225-55gal	NCT-225-pt-ctr	NCT-225-pt-tcor	NCT-225-pt-side	HAC-225-fullcav	HAC-225-pt-tcor
Location			**Relative Error for Max(Response + RE)**							
NCT	2 m	Side	0.4%	0.3%	0.3%	0.2%	1.2%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	0.5%	0.5%	0.5%	0.4%	0.5%	N/A	N/A	N/A
NCT	Surface	Side (body)	0.8%	0.3%	0.3%	0.2%	7.8%	0.6%	N/A	N/A
NCT	Surface	Top	1.4%	1.4%	1.4%	0.9%	1.4%	N/A	N/A	N/A
NCT	Surface	Bottom	1.3%	1.3%	1.5%	0.9%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	0.4%	1.9%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	2.6%	4.1%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	2.2%	N/A

Allowable Source Derivation for 1.83 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-183-fullcav	NCT-183-25ft3t	NCT-183-55gal	NCT-183-pt-ctr	NCT-183-pt-tcor	NCT-183-pt-side	HAC-183-fullcav	HAC-183-pt-tcor
Location			**Relative Error for Max(Response + RE)**							
NCT	2 m	Side	0.5%	0.4%	0.5%	0.3%	1.5%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	0.7%	0.6%	0.7%	0.5%	0.6%	N/A	N/A	N/A
NCT	Surface	Side (body)	1.1%	0.4%	0.4%	0.3%	8.7%	0.9%	N/A	N/A
NCT	Surface	Top	1.9%	1.8%	1.8%	1.2%	1.8%	N/A	N/A	N/A
NCT	Surface	Bottom	1.8%	1.7%	1.9%	1.2%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	0.6%	2.6%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	3.3%	5.1%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	1.8%	N/A

Allowable Source Derivation for 1.5 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-150-fullcav	NCT-150-25ft3t	NCT-150-55gal	NCT-150-pt-ctr	NCT-150-pt-tcor	NCT-150-pt-side	HAC-150-fullcav	HAC-150-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	0.4%	0.3%	0.3%	0.2%	2.0%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	0.5%	0.5%	0.5%	0.4%	0.6%	N/A	N/A	N/A
NCT	Surface	Side (body)	0.9%	0.3%	0.3%	0.2%	7.8%	0.5%	N/A	N/A
NCT	Surface	Top	1.2%	1.3%	1.3%	0.8%	2.0%	N/A	N/A	N/A
NCT	Surface	Bottom	1.1%	1.3%	1.3%	0.9%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	0.4%	2.8%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	2.2%	4.8%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	1.9%	N/A

Allowable Source Derivation for 1.17 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-117-fullcav	NCT-117-25ft3t	NCT-117-55gal2	NCT-117-pt-ctr	NCT-117-pt-tcor	NCT-117-pt-side	HAC-117-fullcav	HAC-117-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	0.3%	0.4%	0.3%	0.3%	1.0%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	1.0%	1.8%	1.4%	0.6%	0.6%	N/A	N/A	N/A
NCT	Surface	Side (body)	0.6%	0.4%	0.3%	0.3%	4.4%	0.6%	N/A	N/A
NCT	Surface	Top	0.7%	1.3%	0.8%	0.8%	1.8%	N/A	N/A	N/A
NCT	Surface	Bottom	0.7%	1.1%	0.9%	0.9%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	4.1%	1.8%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	2.2%	3.2%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	2.0%	N/A

Allowable Source Derivation for 0.9 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-090-fullcav	NCT-090-25ft3s	NCT-090-55gal2	NCT-090-pt-ctr	NCT-090-pt-tcor	NCT-090-pt-side	HAC-090-fullcav	HAC-090-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	1.8%	0.4%	0.3%	0.3%	1.8%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	2.0%	2.0%	1.5%	0.4%	0.5%	N/A	N/A	N/A
NCT	Surface	Side (body)	0.9%	0.4%	0.3%	0.3%	3.5%	1.1%	N/A	N/A
NCT	Surface	Top	1.0%	0.8%	0.6%	0.6%	1.5%	N/A	N/A	N/A
NCT	Surface	Bottom	1.0%	0.9%	0.6%	0.6%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	8.2%	2.1%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	2.2%	3.4%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	1.9%	N/A

Allowable Source Derivation for 0.7 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-070-fullcav	NCT-070-25ft3s	NCT-070-55gal2	NCT-070-pt-ctr	NCT-070-pt-tcor	NCT-070-pt-side	HAC-070-fullcav	HAC-070-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	0.3%	2.8%	2.0%	1.8%	1.9%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	2.7%	2.4%	1.7%	1.7%	0.6%	N/A	N/A	N/A
NCT	Surface	Side (body)	2.8%	0.7%	0.6%	0.4%	3.3%	1.9%	N/A	N/A
NCT	Surface	Top	0.9%	0.7%	0.5%	0.5%	1.5%	N/A	N/A	N/A
NCT	Surface	Bottom	0.9%	0.8%	0.5%	0.5%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	6.2%	1.2%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	1.1%	1.9%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	1.0%	N/A

Allowable Source Derivation for 0.5 MeV or lower photons.										
Transport Condition			NCT						HAC	
Source Case			Full Cavity	2.5 ft^3	55 gal	Centered Pt	Corner Pt.	Side Point	Full Cavity	Corner Pt.
MCNP Case			NCT-050-fullcav	NCT-050-25ft3s	NCT-050-55gal2	NCT-050-pt-ctr	NCT-050-pt-tcor	NCT-050-pt-side	HAC-050-fullcav	HAC-050-pt-tcor
Location			Relative Error for Max(Response + RE)							
NCT	2 m	Side	2.6%	2.1%	2.4%	1.5%	2.7%	N/A	N/A	N/A
NCT	Surface	Side (I.L.)	1.9%	1.5%	1.6%	1.0%	0.8%	N/A	N/A	N/A
NCT	Surface	Side (body)	2.8%	2.2%	2.4%	1.0%	2.4%	2.6%	N/A	N/A
NCT	Surface	Top	0.5%	0.3%	0.4%	0.2%	1.3%	N/A	N/A	N/A
NCT	Surface	Bottom	0.5%	0.4%	0.4%	0.2%	N/A	N/A	N/A	N/A
HAC	1 m	Side	N/A	N/A	N/A	N/A	N/A	N/A	8.3%	3.1%
HAC	1 m	Top	N/A	N/A	N/A	N/A	N/A	N/A	1.1%	4.3%
HAC	1 m	Bottom	N/A	N/A	N/A	N/A	N/A	N/A	0.9%	N/A

ENERGYSOLUTIONS

September 20, 2013
ES/NRC 13-019
Docket No. 71-9168

ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Response to Request for Additional Information for the Model No. 8-120B Package, Docket No. 71-9168**

Reference: Letter from P. Saverot (NRC) to S. Sisley (Energy*Solutions*), "Request for Additional Information for the Model No. 8-120B Package, Docket No. 71-9168," September 16, 2013, ADAMS Accession Number ML13260A396.

Dear Sir or Madam:

By the referenced letter, NRC requested that Energy*Solutions* (ES) provide additional information needed for NRC staff to complete their review of the application to amend Certificate of Compliance (CoC) No. 9168 for the 8-120B Shipping Package. ES hereby provides the additional information requested by NRC in the referenced letter, as described in Enclosure 1. Enclosure 2 contains one (1) paper copy of the non-public version of the revised 8-120B Safety Analysis Report (SAR) that contains security-related sensitive information that should be withheld under 10 CFR 2.390. Enclosure 3 contains one (1) paper copy of the public version of the revised 8-120B SAR in which all proprietary information and security-related sensitive information is redacted. A summary of changes included in the 8-120B SAR is provided in Attachment 1 of this letter.

Should you or any member of your staff have questions, please contact the undersigned at (408) 558-3509.

Sincerely,

Steven E. Sisley
Cask Licensing Manager
Energy*Solutions*

Attachments:
(1) Summary of Changes, 8-120B Consolidated SAR, Revision 6 (2 pages)

2105 South Bascom Ave., Suite 230 • Campbell, California 95008
408.558.3500 • Fax 408.558.3518 • www.energysolutions.com

Enclosures:
1) Response to Request for Additional Information.
2) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 6, September 2013, Non-Public Version (1 paper copy), **(Security-Related Information – Withhold Under 10 CFR 2.390).**
3) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 6, September 2013, Public Version (1 paper copy).

cc
Mr. Pierre Saverot, Division of Spent Fuel Storage and Transportation
Mr. Dan Shrum, Energy*Solutions*

The following is a summary of the changes incorporated in Revision 6 of the 8-120B Consolidated Safety Analysis Report. The revisions indicators in the margins of Revisions 4 and 5 of the 8-120B Consolidated Safety Analysis Report have also been included in Revision 6 to indicate the cumulative changes that have been made in association with the request to amend the 8-120B CoC. However, the summary of the changes incorporated in Revisions 4 and 5 of the 8-120B Consolidated Safety Analysis Report are not repeated below.

Summary of Changes, 8-120B Consolidated SAR, Revision 6

Section	Page(s)	Change	Purpose
Table 4-2, Caption	4-22	Corrected to refer to 8-120B.	Editorial correction.
Table 4-2, Footnote **	4-22	Deleted note regarding exemption from pre-shipment leak testing requirement for LSA material and SCO shipments.	All shipments made in the 8-120B package now require pre-shipment leak testing.
5.1	5-1	Revised referenced procedure step in the last sentence of first paragraph.	Editorial correction.
5.7	5-18	Corrected revision number of Reference 5.7.2.	Editorial correction.
7.1.10 through 7.1.13	7-3, 7-4	Change step number from 7.1.9B to 7.1.10 and renumbered all subsequent steps accordingly.	Revised to avoid confusion since "A" steps are associated with loading through the cask secondary lid.
7.1.10	7-3	Revised second sentence and associated footnote.	Clarify conditions under which the requirement is waived and the basis for waiving the requirement.
7.1.14 through 7.1.21.5	7-4, 7-5	Change step number from 7.1.12A to 7.1.14 and renumbered all subsequent steps accordingly.	Revised to avoid confusion since "A" steps are associated with loading through the cask secondary lid.
7.1.14	7-4	Revised step and deleted note regarding exemption from pre-shipment leak testing requirement for LSA material and SCO shipments.	All shipments made in the 8-120B package now require pre-shipment leak testing.

Summary of Changes, 8-120B Consolidated SAR, Revision 6

Section	Page(s)	Change	Purpose
8.3.2.2.a	8-9	Deleted note regarding exemption from pre-shipment leak testing requirement for LSA material and SCO shipments.	All shipments made in the 8-120B package now require pre-shipment leak testing.
8.3.2.2.b	8-9	Added the required pre-shipment leak test pressure.	Editorial clarification.
8.3.2.2.d	8-9	Revised to clarify that the allowable pressure drop is 0.1 psig and that the maximum graduation (not sensitivity) of the pressure guage shall be 0.1 psig.	Editorial correction.

Enclosure 1

Responses to Request for Additional Information

(2 pages total)

The response to the NRC Request for Additional Information (RAI) associated with the Energy*Solutions* request to amend the Certificate of Compliance (CoC) for the Model No. 8-120B Shipping Package is provided herein. The NRC RAI question, which is shown in *italics*, is followed by the ES response and a summary of the resulting changes to the 8-120B Safety Analysis Report.

QUESTION:

During the review of your application for revision to Certificate of Compliance (CoC) No. 9168 for the Model No. 8-120B package, EnergySolutions submitted a notification, dated August 14, 2013, regarding the failure to observe CoC Conditions for the package vent port leak test hold time (ADAMS Accession Number ML13247A179).

In connection with this notification, we need you to (i) provide complete calculations for the test vent port volume used in the pressure drop test, (ii) clarify the volume (combined test manifold and small residual volume inside the vent port, or small residual volume inside the vent port) that is less than 34.4 cm^3, and (iii) also clarify if the value of 34.4 cm^3 is correct.

*Your notification states the following: "The vent port test volume (the staff interprets this to be the total of the test vent port volume and test manifold volume) is equal to the combined volume of the test manifold (10 cm^3) plus a very small residual volume inside the vent port (the staff interprets this to be the test vent port volume), which is less than 34.4 cm^3." However, you do not specifically state the value of the small residual volume inside the vent port or show how it was calculated. The calculation of the test vent port volume used in the pressure drop test is necessary to show that the test vent port volume in addition to the maximum test manifold volume (10 cm^3) is less than one third of the total of the primary containment seal test chamber volume and the maximum test manifold volume (20 min / 60 min * (103.2 cm^3 + 10 cm^3) = 37.3 cm^3), for the 20 minute hold time to be adequate. The staff calculated that the test vent port volume must be less than 37.3 cm^3 – 10 cm^3 = 27.3 cm^3 for the 20 minute hold time to be adequate.*

We need this information to determine compliance with 10 CFR 71.51(a)(1) and (2), and request that you provide this information by September 30, 2013. We do recognize that this calculation applies to the old lids, not to the new lids that will be used for all future shipments, but it is our intent to explain staff's position on leak testing in the Safety Evaluation Report pertaining to the amendment request currently under review.

RESPONSE:

Figure 1 shows the test manifold configuration used for the assembly verification leak test of the 8-120B vent port evaluated in Section 4.4 of the July, 2012 SAR Addendum. The vent port test flange is affixed to the lid, and the test manifold (partially shown in Figure 1) is screwed into the test flange. The volume of the test manifold, V_M, is required to be less than 10 cm^3.

The total vent port test volume equals $V_M + V_1 + V_2 - V_3$, where V_1 is the small volume inside the ∅3/8" threaded hole of the test port flange between the bottom end of the test manifold and the top plane of the lid, V_2 is the volume of the ∅1.25" x 3/8" deep countersunk hole in the lid

(sans bolt), and V_3 is the conservative lower bound estimate of volume of the vent port plug, i.e., the ½" hex cap screw head volume (calculated as a ∅3/4" x 5/16" high.) The volume of the vent plug Stat-O-Seal is conservatively neglected.

$$V_1 = 1/8 \text{ in} * \pi/4 * (3/8 \text{ in})^2 * (2.54 \text{ cm/in})^3 = 0.23 \text{ cm}^3$$

$$V_2 = 3/8 \text{ in} * \pi/4 * (1.25 \text{ in})^2 * (2.54 \text{ cm/in})^3 = 7.54 \text{ cm}^3$$

$$V_3 \approx 5/16 \text{ in} * \pi/4 * (3/4 \text{ in})^2 * (2.54 \text{ cm/in})^3 = 2.26 \text{ cm}^3$$

Therefore, the total vent port test volume, including the test manifold volume, is calculated to be 15.5 cm^3 (i.e., 10 + 0.23 + 7.54 – 2.26), which is much less than the 37.3 cm^3 limit calculated by the NRC staff. The lower vent port test volume limit of 34.4 cm^3 given in the referenced notification was based on a calculation that conservatively neglected the 10 cm^3 manifold volume. With the inclusion of the test manifold volume, we concur with the NRC staff's calculated vent port test volume limit of 37.3 cm^3 for the 20-minute hold time to be adequate.

Summary of SAR changes:

- None.

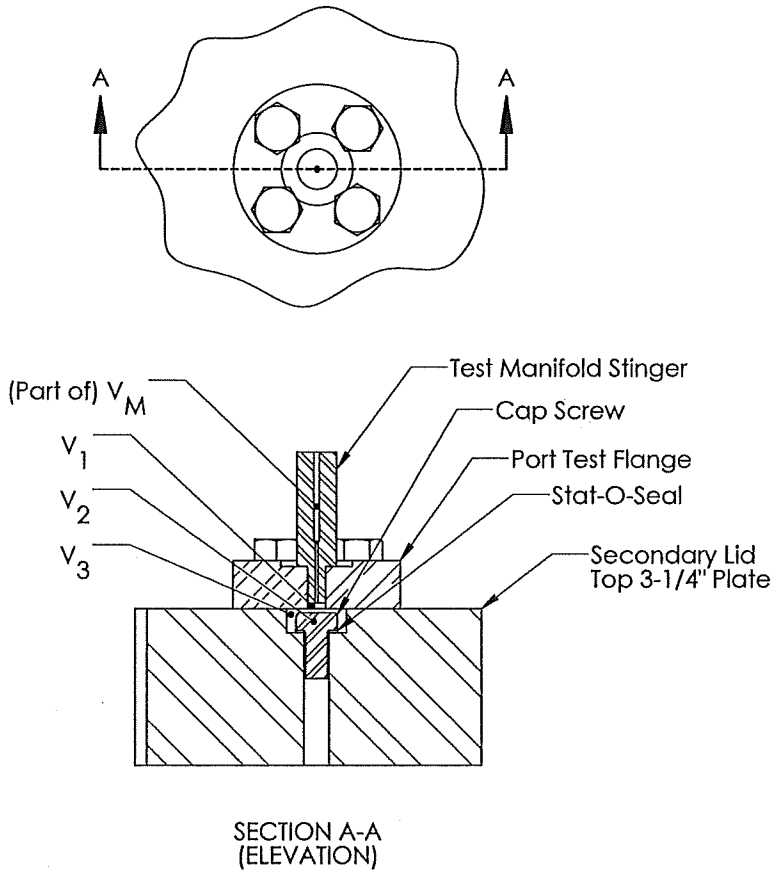


Figure 1 – Vent Port Test Configuration

ENERGYSOLUTIONS

November 13, 2013
ES/NRC 13-025
Docket No. 71-9168

ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Additional Information for Amendment Request for Certificate of Compliance No. 9168 for the Energy*Solutions* 8-120B Type B Shipping Package, Docket No. 71-9168**

Dear Sir or Madam:

Energy*Solutions* hereby submits to NRC the enclosed Safety Analysis Report (SAR) for Model 8-120B Type B Shipping Package, Consolidated Revision 7, dated November 2013. This SAR revision includes changes that address recent discussions with NRC regarding the draft Certificate of Compliance (CoC) for the amendment request. Enclosure 1 contains one (1) paper copy of the non-public version of the revised 8-120B Safety Analysis Report (SAR) that contains security-related sensitive information that should be withheld under 10 CFR 2.390. Enclosure 2 contains one (1) paper copy of the public version of the revised 8-120B SAR in which all security-related sensitive information is redacted. A summary of changes included in the 8-120B SAR is provided in Attachment 1 of this letter.

Should you or any member of your staff have questions, please contact the undersigned at (408) 558-3509.

Sincerely,

Steven E. Sisley
Cask Licensing Manager
Energy*Solutions*

Attachments:
(1) Summary of Changes, 8-120B Consolidated SAR, Revision 7 (1 page)

2105 South Bascom Ave., Suite 230 • Campbell, California 95008
408.558.3500 • Fax 408.558.3518 • www.energysolutions.com

Enclosures:

1) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 7, November 2013, Non-Public Version (1 paper copy), **(Security-Related Information – Withhold Under 10 CFR 2.390).**
2) Safety Analysis Report for the Model 8-120B Type B Shipping Packaging, Consolidated Revision 7, November 2013, Public Version (1 paper copy).

cc
Mr. Pierre Saverot, Division of Spent Fuel Storage and Transportation
Mr. Dan Shrum, Energy*Solutions*

The following is a summary of the changes incorporated in Revision 7 of the 8-120B Consolidated Safety Analysis Report. The revisions indicators in the margins of Revisions 4 through 6 of the 8-120B Consolidated Safety Analysis Report have also been included in Revision 7 to indicate the cumulative changes that have been made in association with the request to amend the 8-120B CoC. However, the summary of the changes incorporated in Revisions 4 through 6 of the 8-120B Consolidated Safety Analysis Report are not repeated below.

Summary of Changes, 8-120B Consolidated SAR, Revision 7

Section	Page(s)	Change	Purpose
1.2.2.3	1-5	Correct section cross-reference in 1st sentence of 3rd paragraph.	Editorial correction.
7.0	7-1	Revised last paragraph of section to reference Section 8.3.2.1 for the leak test requirements for powdered solid shipments.	Leak test requirements for leaktight status from Section 4.9 are added to Chapter 8.
7.1.14	7-4	Added word "every" before shipment and added footnote 2.	Added clarification and basis for requirement.
7.1.21.6	7-5	New requirement added.	Requirement added to assure cask has received the required periodic leak testing prior to shipment.
8.3.2.1	8-6, 8-7	Revised to include leak testing requirements for powdered solid shipments.	Leak test requirements for leaktight status from Section 4.9 are added to Chapter 8.
Table 8-1	8-8	Added Note 1.	Clarify the periodic leak testing requirements for shipments of powdered radioactive materials.
8.3.2.2.d	8-9	Deleted last sentence.	Pressure gauge graduation requirement is not necessary.

ES/NRC 13-025
November 13, 2013

Enclosure 1

Safety Analysis Report for the Model 8-120B Type B Shipping Packaging
Consolidated Revision 7, November 2013
Non-Public Version
(1 paper copy)

(Security-Related Information – Withhold Under 10 CFR 2.390)

Enclosure 2

Safety Analysis Report for the Model 8-120B Type B Shipping Packaging
Consolidated Revision 7, November 2013
Public Version
(1 paper copy)

ENERGYSOLUTIONS

Letterbook No.: ES/NRC 13-026
Docket No. 71-9168
November 13, 2013

Mr. Pierre Saverot
U.S. Nuclear Regulatory Commission
Division of Spent Fuel Storage and Transportation/Licensing Branch
11555 Rockville Pike
MS 3WFN-14A44
Rockville, MD 20852

Subject: **Consolidated Summary of Changes for the Energy*Solutions* 8-120B Type B Shipping Package SAR**

References: (1) Letter from Energy*Solutions* (S. Sisley) to NRC, Subject: Amendment Request for Certificate of Compliance No. 9168 for the Energy*Solutions* 8-120B Type B Shipping Package, Letterbook No. ES/NRC 13-010, May 23, 2013.

(2) Letter from Energy*Solutions* (S. Sisley) to NRC, Subject: Inadvertent Omissions from Amendment Request for Certificate of Compliance No. 9168 for the Energy*Solutions* 8-120B Type B Shipping Package, Letterbook No. ES/NRC 13-013, July 3, 2013.

(3) Letter from Energy*Solutions* (S. Sisley) to NRC, Subject: Response to Request for Additional Information for the Model No. 8-120B Package, Docket No. 71-9168, Letterbook No. ES/NRC 13-017, August 9, 2013.

(4) Letter from Energy*Solutions* (S. Sisley) to NRC, Subject: Response to Request for Additional Information for the Model No. 8-120B Package, Docket No. 71-9168, Letterbook No. ES/NRC 13-019, September 20, 2013.

(5) Letter from Energy*Solutions* (S. Sisley) to NRC, Subject: Additional Information for Amendment Request for Certificate of Compliance No. 9168 for the Energy*Solutions* 8-120B Type B Shipping Package, Docket No. 71-9168, Letterbook No. ES/NRC 13-025, November 13, 2013.

Dear Mr. Saverot:

In support of the most recent request to amend the 8-120B Certificate of Compliance (CoC), Energy*Solutions* submitted multiple revisions of the Safety Analysis Report in References 1 through 5. Attached to each of the referenced letters is a Summary of Changes specific to the revision of the SAR submitted with the letter. For completeness and to summarize all SAR changes made in support of the subject CoC amendment request, a Consolidated Summary of Changes to the 8-120B SAR has been prepared and is included in Attachment 1. This is provided only for your convenience since the same information was provided to NRC piecemeal in the referenced letters.

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Should you or your staff have questions, please contact the undersigned.

Sincerely,

Steven E. Sisley
Licensing Manager
Energy*Solutions* Products and Technology Group
(408) 558-3509
E-Mail: ssisley@energysolutions.com

Attachments:
(1) Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7 (9 pages)

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
Consolidated Revision 4 Changes (Reference 1)			
Front Matter	xiv	Added blank page. (1)	Editorial – formatting for two-sided printing.
1.2.1	1-1	Expanded description of impact limiter skin and cover plates.	Revised for clarity.
1.2.1.3	1-3	Changed maximum payload weight.	Reduced to offset additional weight of plate added to lower impact limiter in order to maintain maximum package weight.
1.2.1.5	1-3	Deleted comma from section heading	Editorial correction.
1.3	1-7	Added list of drawings included in SAR.	Editorial – for clarity.
---	1-8	Added blank page.	Editorial – formatting for two-sided printing.
1.3	---	Revised Dwg. No. C-110-E-0007: 1) Added ½-inch thick plate (Item 56) to cover central region of the Lower Impact Limiter, 2) Revised thickness of impact limiter skin, and 3) Removed non-critical dimensions on the impact limiter lift lug (Items 45A and 46.)	Purposes of drawing changes are as follows: 1) Plate added for shielding, 2) Editorial correction for consistency with safety analyses, and 3) Removed dimensions not used in Safety Analyses.
2.1.1	2-2	Revised "Impact Limiter" section to discuss plates covering the central regions of the upper and lower impact limiters.	Revised for clarity.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
2.1.3	2-4	Changed section for the following: 1) Changed the word "conservative" to "nominal" in first sentence, 2) Reduced "Payload" weight to offset additional weight of plate added to lower impact limiter, 3) Deleted separate line for "Thermal Shield" weight and combined weight of the thermal shield and plate added to lower impact limiter in "Misc." line, and 4) Added discussion of possible shift in package center of gravity due to eccentric payload configurations.	Purposes of revisions to section are as follows: 1) Weights are based on nominal dimensions. 2) Maintain overall package weight within limit. 3) Simplify weight summary. 4) Added to clarify that the effect of payload configuration on the package center of gravity is not significant and does not require separate evaluations of payload configurations.
2.6.10	2-28(2)	Changed to include thicknesses of the weather cover on the impact limiter and the plate added to the lower impact limiter.	Address impact of penetration test on impact limiter cover plates.
2.7.8	2-57	Add discussion of damage to impact limiter covers resulting from HAC puncture test.	Added for completeness and consistency with existing safety analyses.
Figure 2-1	2-85	Changed graphic to show cover plate on lower impact limiter.	More accurately depict design configuration.
Figure 2-5	2-89	Added figure caption.	Editorial – figure caption missing in previous SAR revision.
3.1.1	3-1	Changed discussion to include the plate added to the lower impact limiter.	Added for completeness and consistency with existing safety analyses.
3.3	3-2	Revised 2nd paragraph to discuss treatment of impact limiters in thermal analysis.(3)	Editorial clarification.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
3.4	3-6	Added discussion of potential damage to impact limiter cover plates resulting from the HAC puncture test and the damaged configuration considered in the HAC fire evaluation.	Added for completeness and consistency with existing safety analyses.
---	3-38	Added blank page.	Editorial – formatting for two-sided printing.
5.1.1	5-1	Changed to discuss shielding design features of the radial thermal barrier, impact limiter skins, and plate added to lower impact limiter.	Components are credited for shielding in the revised shielding evaluation.
Table 5-1	5-2	Changed package dose rate results.(4)	Updated based on results of revised shielding evaluation.
5.1.2.2	5-2	Expanded parenthetical discussion of point source modeling.	Clarify reason for point source location.
5.1.2.3	5-3	Changed allowable source strengths.	Updated based on results of revised shielding evaluation.
5.3.1.1	5-4	Revised 2nd sentence to discuss treatment of plate tolerances in shielding model.	Added for completeness and consistency with revised safety analyses.
5.4.1	5-8	Revised the discussion of conservatism in the shielding model to include modeling minimum steel plate thicknesses.	Added for completeness and consistency with revised safety analyses.
Table 5-5	5-11	Changed table to report results of revised shielding evaluation.(4)	Updated based on results of revised shielding evaluation.
Figure 5-3	5-12	Changed figure to report results of revised shielding evaluation.(4)	Updated based on results of revised shielding evaluation.
Figure 5-4	5-13	Changed figure to report results of revised shielding evaluation.(4)	Updated based on results of revised shielding evaluation.
---	6-2	Added blank page.	Editorial – formatting for two-sided printing.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
Table 7-1	7-10	Changed table to report results of revised shielding evaluation.(4)	Updated based on results of revised shielding evaluation.
Attachment 1, Example 1, Steps 5-7	7-14	Revised example data.(4)	Updated based on results of revised shielding evaluation.
Attachment 1, Example 2, Steps 5-7	7-16	Revised example data.(4)	Updated based on results of revised shielding evaluation.
Attachment 1, Example 3, Steps 5-7	7-18	Revised example data.(4)	Updated based on results of revised shielding evaluation.
Attachment 1, Example 4, Steps 5-7	7-21	Revised example data.(4)	Updated based on results of revised shielding evaluation.
Attachment 1, Example 5, Step 3	7-22 and 7-23	Revised selected example parameters.(4)	More pertinent example chosen based on revised shielding analysis results.
Attachment 1, Example 5, Steps 5-7	7-23 and 7-24	Revised example data.(4)	Updated based on results of revised shielding evaluation.
---	7-26	Added blank page.	Editorial – formatting for two-sided printing.
July 2012 SAR Addendum	All	Deleted.	No longer applicable.
Consolidated Revision 4 Changes, Inadvertent Ommissions (Reference 2)			
7.1.8	7-3	Change section cross-reference in second note.	Editorial correction.
7.1.9B	7-3	Step added to address Condition 7 in CoC Revision 19.(5)	Requirement incorporated in SAR Operating Procedures.
7.1.12A	7-4	Step added to address Condition 11 in CoC Revision 19.(5)	Requirement incorporated in SAR Operating Procedures.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
Consolidated Revision 5 Changes (Reference 3)			
Front matter	xiv	Added revision control sheet.	Editorial change.
2.2.1	2-5	Replaced reference to specification.	Editorial change. Appendix 1, Section 8 changed to References.
3.2.2	3-2	Corrected O-ring durometer specification (1st bullet) and replaced references to specifications (1st and 3rd bullets).	Editorial correction for consistency with drawing and Section 8 references.
Chapter 4	All	Chapter 4 has been re-typeset in its entirety. Formatting changes are not marked as revisions. All other changes are described below.	Editorial change.
4.0	4-1	Deleted "CNS" from the model designation.	Editorial change.
4.2.2	4-5	Corrected referenced equation numbers for $F_{mn}(D_{max})$ and $F_{cn}(D_{max})$.	Editorial correction.
4.2.3	4-6	Clarified basis for assumed weight used in containment calculation.	Editorial correction.
4.3	4-7	Revised heading text.	Editorial change.
4.6	4-19	Corrected equation to divide $L_{He}(T_F)$ by 2.	Editorial correction.
4.7	4-19	Revised 2nd sentence to clarify that the pre-shipment leak test of the vent port is not a condition of whether the vent port plug has or has not been removed.	Pre-shipment leak test required for all Type B shipments, except for LSA material and SCO material that is exempt under 10 CFR 71.14(b)(3)(i).
4.7.1	4-20	Corrected units for parameter L.	Editorial correction.
Appendix 4.1	4-30	Added blank page for 2-sided printing.	Editorial change.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
5.1.1	5-1	Revised 1st paragraph to discuss presence of cask cavity cladding. Deleted last sentence of paragraph.	Revised in response to RAI 5-2.
Table 5-1	5-2	Dose rates updated based on revised shielding analysis.	Revised in response to RAI 5-6
5.1.2.3	5-3	Corrected Table 5-1 cross reference in last sentence of 1st paragraph.	Editorial correction.
5.3.1.1	5-4	Revised to discuss application of tolerances, modeling of the cask cavity liner (cladding) and radial thermal barrier, and adjustments to impact limiter model to account for effects of NCT drop tests.	Revised in response to RAI 5-2 and 5-6.
5.4.1	5-8	Added text to "Analysis Method Uncertainties and Conservatisms" section to discuss results with relative error levels between 0.05 and 0.1 and tallies that do not pass all 10 statistical checks performed by MCNP.	Revised in response to RAI 5-7.
Table 5-5, Figure 5-3, Figure 5-4	5-11 thru 5-13	Updated to reflect results of revised shielding analysis.	Revised in response to RAI 5-6 and 5-7.
7.1.9B	7-3	Revised step and added footnote to clarify when the requirement is waived.(5)	Revised in response to RAI 7-1.
Table 7-1 and examples in Attachment 1 of Chapter 7	7-10, 7-14, 7-16, 7-18, 7-21 thru 7-24.	Updated to reflect results of revised shielding analysis.	Revised in response to RAI 5-6 and 5-7.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
8.2.5	8-5	Revised to clarify required testing for containment seals (2nd bullet) and replaced reference to specification (3rd bullet).	Revised to address issue identified during inspection of fabrication activities and editorial change.
8.4	8-11	Changed section from an appendix to references.	Specifications, which were not included in the appendix, are references. The section has been revised to reflect this.
Consolidated Revision 6 Changes (Reference 4)			
Table 4-2, Caption	4-22	Corrected to refer to 8-120B.	Editorial correction.
Table 4-2, Footnote **	4-22	Deleted note regarding exemption from pre-shipment leak testing requirement for LSA material and SCO shipments.	All shipments made in the 8-120B package now require pre-shipment leak testing.
5.1	5-1	Revised referenced procedure step in the last sentence of first paragraph.	Editorial correction.
5.7	5-18	Corrected revision number of Reference 5.7.2.	Editorial correction.
7.1.10 through 7.1.13	7-3, 7-4	Change step number from 7.1.9B to 7.1.10 and renumbered all subsequent steps accordingly.	Revised to avoid confusion since "A" steps are associated with loading through the cask secondary lid.
7.1.10	7-3	Revised second sentence and associated footnote.	Clarify conditions under which the requirement is waived and the basis for waiving the requirement.
7.1.14 through 7.1.21.5	7-4, 7-5	Change step number from 7.1.12A to 7.1.14 and renumbered all subsequent steps accordingly.	Revised to avoid confusion since "A" steps are associated with loading through the cask secondary lid.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
7.1.14	7-4	Revised step and deleted note regarding exemption from pre-shipment leak testing requirement for LSA material and SCO shipments.	All shipments made in the 8-120B package now require pre-shipment leak testing.
8.1.3	8-1	Revised 6th bullet in section to reflect current drain configuration.(6)	Editorial clarification.
8.3.2.2.a	8-9	Deleted note regarding exemption from pre-shipment leak testing requirement for LSA material and SCO shipments.	All shipments made in the 8-120B package now require pre-shipment leak testing.
8.3.2.2.b	8-9	Added the required pre-shipment leak test pressure.	Editorial clarification.
8.3.2.2.d	8-9	Revised to clarify that the allowable pressure drop is 0.1 psig and that the maximum graduation (not sensitivity) of the pressure guage shall be 0.1 psig.	Editorial correction.
Consolidated Revision 7 Changes (Reference 5)			
1.2.2.3	1-5	Correct section cross-reference in 1st sentence of 3rd paragraph.	Editorial correction.
7.0	7-1	Revised last paragraph of section to reference Section 8.3.2.1 for the leak test requirements for powdered solid shipments.	Leak test requirements for leaktight status from Section 4.9 are added to Chapter 8.
7.1.14	7-4	Added word "every" before shipment and added footnote 2.	Added clarification and basis for requirement.
7.1.21.6	7-5	New requirement added.	Requirement added to assure cask has received the required periodic leak testing prior to shipment.
8.3.2.1	8-6, 8-7	Revised to include leak testing requirements for powdered solid shipments.	Leak test requirements for leaktight status from Section 4.9 are added to Chapter 8.

Consolidated Summary of Changes, 8-120B Consolidated SAR, Revisions 4 through 7

Section	Page(s)	Change	Purpose
Table 8-1	8-8	Added Note 1.	Clarify the periodic leak testing requirements for shipments of powdered radioactive materials.
8.3.2.2.d	8-9	Deleted last sentence.	Pressure gauge graduation requirement is not necessary.

Notes:

(1) Blank page deleted in later SAR revision.

(2) Page 2-29 in SAR Consolidated Revision 7 due to repagination.

(3) Inadvertently omitted from Summary of Changes in Reference 1.

(4) Later revised in SAR Consolidated Revision 5 in response to RAI.

(5) Step number changed in SAR Consolidated Revision 6.

(6) Inadvertently omitted from Summary of Changes in Reference 4.